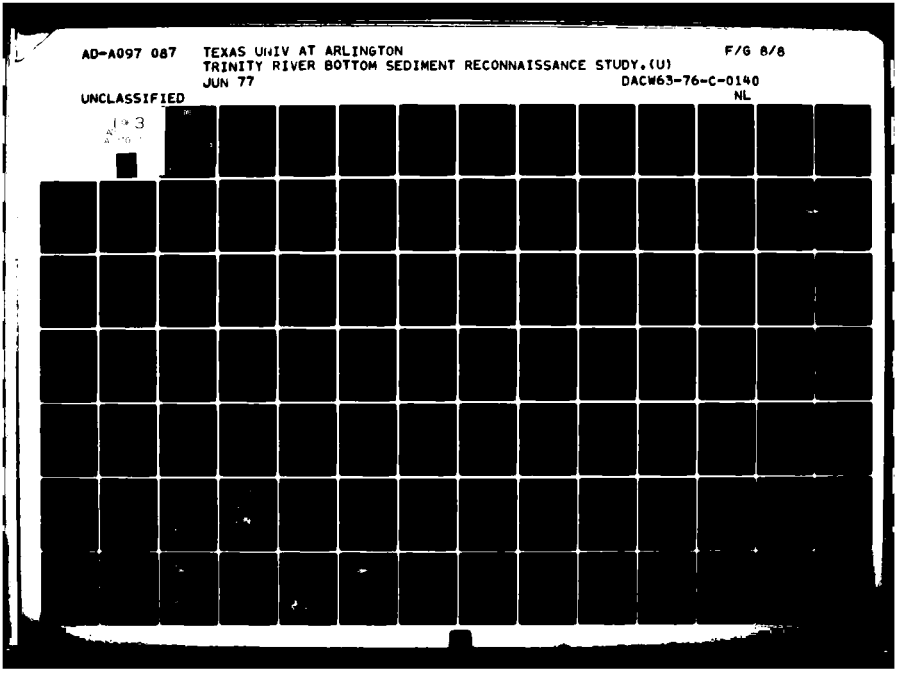
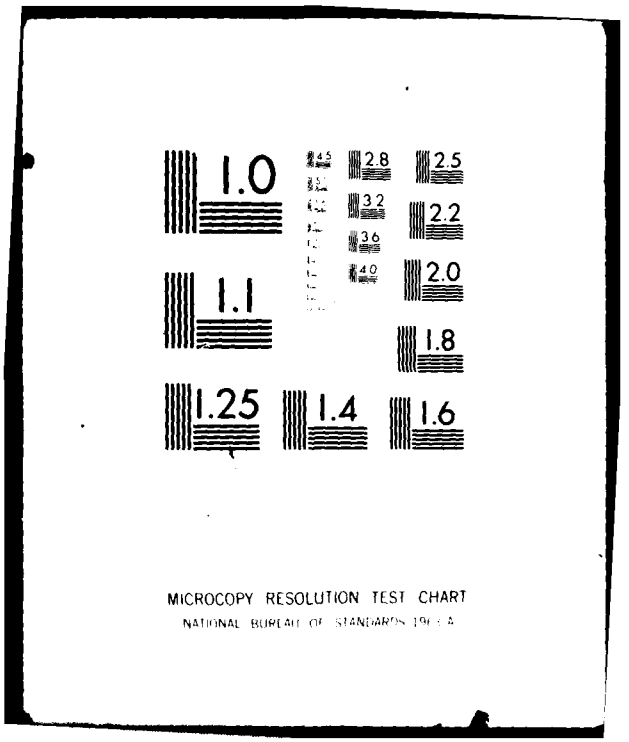

AD-A097 087
TEXAS UNIV AT ARLINGTON
TRINITY RIVER BOTTOM SEDIMENT RECONNAISSANCE STUDY.(U)
JUN 77
F/G 8/8
DACW63-76-C-0140
NL
UNCLASSIFIED


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

LEVEL II

8 fw

AD A097087

FINAL REPORT

TRINITY RIVER BOTTOM SEDIMENT RECONNAISSANCE STUDY

Prepared for

FORT WORTH DISTRICT CORPS OF ENGINEERS
FORT WORTH, TEXAS

Prepared Under Contract No. DACW 63-76-C-0140

Prepared by
THE UNIVERSITY OF TEXAS AT ARLINGTON
Arlington, Texas 76019

June 1977

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A097 087
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) (6) Trinity River Bottom Sediment Reconnaissance Study. Final Report.	5. TYPE OF REPORT & PERIOD COVERED Final Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) The University of Texas at Arlington (15)	8. CONTRACT OR GRANT NUMBER(s) DACW63-76-C-0140
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer District, Fort Worth P. O. Box 17300 Fort Worth, Texas 76102 (12) 224	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U. S. Army Engineer District, Fort Worth P. O. Box 17300 Fort Worth, Texas 76102 (11)	12. REPORT DATE Jun[redacted]77
	13. NUMBER OF PAGES 217 pages
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) NA (9) Final rept.	15. SECURITY CLASS. (of this report) Unclas
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; unlimited distribution.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Approved for public release ; unlimited distribution.

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Chemical analysis
Sedimentation
Trinity River Project, Texas
Trinity River Reconnaissance Study

20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This reconnaissance study was conducted to develop preliminary data on the quality of river water and bottom sediments in various areas of the Trinity River and determine the mobility of various contamimants when bottom sediments are mixed with river water under simulated dredging conditions. Chemical analyses were conducted on filtered and unfiltered river water, filtered and unfiltered elutriates and bottom sediments. Also, static bioassays were conducted on filtered and unfiltered elutriates using the test organism Daphnia magna. Study indicates that some sub areas of the Trinity River were unfit for D. magna and

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

388264

A

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. probably for other forms of aquatic life while in other sub areas survival was excellent in river water and elutriates. Pollutants appear to be the limiting factor for survival of test organisms.

FINAL REPORT

TRINITY RIVER BOTTOM SEDIMENT RECONNAISSANCE STUDY

Prepared for

FORT WORTH DISTRICT CORPS OF ENGINEERS
FORT WORTH, TEXAS

Prepared Under Contract No. DACW 63-76-C-0140

Prepared by

THE UNIVERSITY OF TEXAS AT ARLINGTON
Arlington, Texas 76019

June 1977

The University of Texas at Arlington
Arlington, Texas 76019

Department of Civil Engineering
P.O. Box 19308

June 20, 1977

Mr. Robert E. Lyman
General Planning Section
Fort Worth District Corps of Engineers
P.O. BX 17300
Fort Worth, TX 76102

Dear Mr. Lyman:

Enclosed are 25 copies of our final report, "Trinity River Bottom Sediment Reconnaissance Study." This work was performed by the University of Texas at Arlington under contract No. DACW63-76-C-0140. This report includes the results of field and laboratory analyses conducted on water and bottom sediment samples collected from the Trinity River. We believe the results of this research mark an important beginning in assessing the water and sediment quality of the Trinity River, and mobility of the contaminants from the sediments during dredging operations.

We have enjoyed working with you on this project. The final report incorporates helpful suggestions made by you and your staff. We will appreciate your comments on this report and hope that we can work together in the future.

Sincerely yours,

Syed R. Qasim, Ph.D., P.E.
Associate Professor

SRQ:at

Enclosure

THE CONTENTS OF THIS REPORT ARE NOT TO BE USED FOR ADVERTISING, PUBLICATION, OR PROMOTIONAL PURPOSES. CITATION OF TRADE NAMES DOES NOT CONSTITUTE AN OFFICIAL ENDORSEMENT OR APPROVAL OF THE USE OF SUCH COMMERCIAL PRODUCTS.

FOREWORD

The work presented in this report was performed by the University of Texas at Arlington under contract No. DACW 63-76-C-0140 from the Fort Worth District Corps of Engineers. This report presents the results of the tests conducted during the Trinity River Reconnaissance Study to determine the quality of river water and bottom sediments and to determine the possible mobility of contaminants from the sediments during dredging operations. This program was a cooperative effort of the Department of Civil Engineering and the Department of Chemistry at the University of Texas at Arlington. The Department of Civil Engineering conducted field sampling, elutriation and sample preparation, toxicity and related tests, and determination of solids, nitrogen, phosphorus, chemical oxygen demand, dispersion analyses, and grain size distribution. The Department of Chemistry performed heavy metals, pesticides, carbon, and oil and grease analyses. Dr. Syed R. Qasim, Associate Professor of Civil Engineering, and Dr. Andrew Armstrong, Associate Professor of Chemistry, coordinated the efforts of their respective departments. Dr. Qasim was Project Manager. Personnel who assisted on the project and their responsibilities are summarized below:

Wallace Clines, Vern Sorgee, Kapil Goyal and Don Gates performed sampling and field data collection. Betty Jordan and Vernon Walling conducted toxicity and related tests and nitrogen determinations in water and sediment samples. P. R. Talluri and A. Balaram performed elutriation and sample preparation, solids determinations, and dispersion tests. In addition, Vern Sorgee performed chemical oxygen demand and nitrogen determinations and prepared computer graphics. Kapil Goyal conducted phosphorus tests. Marshall Addison, under direction of Dr. Tom Petry, determined grain size distribution of sediment samples. Don Gates and Betty Jordan also assisted in data analysis and

report writing. John Corn conducted oil and grease and carbon determinations. Jan Soraka performed heavy metal analyses. Jane Blumentritt, John Corn, Brinda Cox, and Charles Johnson conducted pesticides determinations. Dr. Janet Potvin of the English Department provided editorial assistance.

David T. Killen, Robert E. Lyman, and Royce W. Mullens of the Fort Worth District Corps of Engineers monitored the contract. Eugene Gann of Fort Worth Branch, U.S. Geological Survey provided the river stage and discharge data.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

General

The primary purposes of this reconnaissance study were to (1) develop preliminary data on the quality of river water and bottom sediments in various Planning Sub-areas[1] of the Trinity River and (2) determine the mobility of various contaminants when bottom sediments are mixed with river water under simulated dredging conditions. Thirteen sampling sites were selected based upon the site selection criteria presented in the "Phase I-Plan of Work."[2] All sites were sampled and field and laboratory analyses were performed in accordance with the procedures given in the "Phase I-Plan of Work." Chemical analyses were conducted on (1) filtered and unfiltered river water, (2) filtered and unfiltered elutriates, and (3) bottom sediments. Static bioassays were conducted on filtered and unfiltered elutriates using the test organism Daphnia magna.

Results

Static Bioassay

High mortality in river water control groups indicated that Planning Sub-areas 5 and 4 of the Trinity River were unfit for habitation by D. magna and probably by other forms of aquatic life. In Planning Sub-areas 3 and 2, survival was excellent in river water and elutriates. This indicated that elutriates and river water in these areas were suitable for aquatic life.

---

[1] Planning Sub-area 5, from Beach Street in Fort Worth to confluence of the East Fork of the Trinity (CRM 551-460); Planning Sub-area 4, from the East Fork of the Trinity to SH 31 at Trinidad (CRM 460-392); Planning Sub-area 3, from SH 31 to the headwaters of Lake Livingston (CRM 392-183); and Planning Sub-area 2, from the headwaters of Lake Livingston to Trinity Bay (CRM 183-0).

[2] "Trinity River Bottom Sediment Reconnaissance Study Phase I - Plan of Work," prepared for the Fort Worth District Corps of Engineers by the University of Texas at Arlington, Contract No. DACW 63-76-C-0140, November 1976.

Ammonia nitrogen, in the presence of other pollutants, appeared to be the limiting factor in growth and survival of the test organisms. Elutriation consistently improved water quality and made it suitable for habitation by D. magna. Filtration of elutriates further improved the water quality for habitation. While ammonia nitrogen concentrations were not significantly lowered by elutriation, the elutriation procedures resulted in the lowering of other pollutant concentrations which increased survival in the elutriates. Ammonia nitrogen concentrations were not decreased significantly by filtration. The greater survival of D. magna in filtered than in unfiltered samples, therefore, was further indication that the effects of ammonia nitrogen were at least partially dependent upon the presence of other pollutants which may have been partly removed by filtration.

The static bioassay results for the four Planning Sub-areas are given below:

(1) Planning Sub-area 5. Poor survival in the river water controls indicated that this area is unfit for habitation by D. magna and probably other forms of aquatic life. Survival was slightly better in the elutriates from the upper reach than that in the lower reach of this area. The lower reach gave poor survival in both river water controls and elutriates. The poor survival was probably due to gross pollution from the discharge of industrial and urban wastewater treatment plants.

(2) Planning Sub-area 4. Survival was very poor in this area. The only test organism to survive was one in 20 percent filtered elutriates.

(3) Planning Sub-area 3. Survival of test organisms in this area was excellent. Survival was generally better in the elutriates than in the control river water.

(4) Planning Sub-area 2. Survival was excellent in this area except for unexplainable high mortality in filtered control and in 20 percent filtered elutriates.

Water and Elutriates

The results of this reconnaissance study indicated that the pH of the river water ranged between 7.1 and 8.1 at the 13 sampling sites. The DO concentration ranged between 4.2 and 11.8 mg/l. The DO concentrations gradually increased from Planning Sub-areas 5 to 2 indicating a gradual improvement in water quality. Immediate oxygen demand results indicated that anaerobic or low (<5 mg/l) DO conditions would probably result in Planning Sub-areas 5, 4, and 3 when bottom sediments were disturbed during dredging operations. The concentrations of most of the pollutants tested decreased from Planning Sub-areas 5 to 2. The recommended EPA limit of 0.016 mg/l for ammonia nitrogen was exceeded at all 13 sampling sites. The dissolved solids concentrations in Planning Sub-areas 5, 4, and 3 ranged between 630 and 110 mg/l. Most of the water samples tested exceeded the 500 mg/l dissolved solids standard for drinking water. No chlordane or PCBs were detected in any of the river water samples.

Elutriation procedures did not give consistent results in relation to the release or uptake of pollutants. The results depended upon the concentration of the pollutant contained in the bottom sediments, the adsorptive capacity of the bottom sediments, and the reduced or oxidized state of the bottom sediments. Filtration generally resulted in a lowering of the pollutant concentration in the river water and elutriates.

(1) Planning Sub-area 5. This area appeared to be the most grossly polluted. The highest concentrations of many pollutants were found in the lower reaches of this area. Most of the heavy metals and pesticides concentrations exceeded the recommended EPA limits (1976). Other pollutants in exceedingly high concentrations in river water were:

Ammonia Nitrogen	9.9 mg/l
Total Kjeldahl Nitrogen	13.7 mg/l
Total Dissolved Solids	610 mg/l
Total Organic Carbon	45 mg/l
Total Phosphorus	7.2 mg/l

(2) Planning Sub-area 4. Although this area does not receive any significant point source pollution, carry-over pollution from upstream resulted in concentrations of many pollutants in water at moderately high levels. In river water samples, chromium, lead, manganese, DDT, dieldrin, endrin, heptachlor, and lindane exceeded the recommended EPA limits (1976).

(3) Planning Sub-areas 3 and 2. The river water in these areas was found to be of better quality than that in upstream areas. However, most of the pesticides and chromium, lead, and manganese exceeded the recommended EPA limits for surface water (1976).

Bottom sediments

All bottom sediments tested from Planning Sub-areas 5, 4, and 3 were anaerobic. The range of Eh was -360 to -15 mv. Pollutant concentrations generally decreased from Planning Sub-areas 5 to 2.

(1) Planning Sub-area 5. The lower reach of this area contained the highest pollutant concentrations in the bottom sediments tested. Many heavy metals and pesticides concentrations, total Kjeldahl nitrogen, volatile solids, and chemical oxygen demand concentrations exceeded the recommended limits for Region VI (1973).

(2) Planning Sub-area 4. Bottom sediments from this area were found to contain much lower concentrations of pollutants than bottom sediments in Planning Sub-area 5. None of the recommended EPA limits were exceeded in this area.

(3) Planning Sub-area 3. The quality of the bottom sediments in this area was further improved over that in the upper reaches. Site 12 in this area was sampled approximately one week after heavy rains. High concentrations of many heavy metals, COD, nitrogen, and phosphorus

were found in the bottom sediments at this site. It appears that the bottom sediments from upper reaches were scoured under high flow conditions and deposited at this site.

(4) Planning Sub-area 2. The concentrations of pollutants in this area were within acceptable limits. Only the concentration of nickel exceeded the EPA limit.

INTRODUCTION

Background

Over the years, pollutants have been building up in the sediments of the ports, harbors, and waterways of the United States. These pollutants come from a variety of sources, including municipal and industrial wastewater outfalls, nonpoint sources, accidental spills, and dredge material disposal. Since many of the pollutants naturally adsorb and chemisorb to the fine sediment particles (clay, silt), the pollutants often are transported considerable distances by the water before settling out. When such particles eventually settle, the result can be a system of in-place pollution or "hot spots" where the level of pollution is considerably higher than in adjacent areas. As a consequence, many of these sediments, when dredged to maintain shipping channels, are classified as "source of pollution."[1]

Recognizing the problems of in-place pollutants in natural water systems, Congress enacted the Federal Water Pollution Control Act Amendment of 1972, PL 92-500. Title I, Section 115 mandates the following action of the Environmental Protection Agency:

> Section 115. The Administrator is directed to identify the location of in-place pollutants with emphasis on toxic pollutants in harbors and navigable waterways and is authorized, acting through the Secretary of the Army, to make contracts for the removal and appropriate disposal of such materials from critical port and harbor areas.

The Administrator of the EPA subsequently proposed guidelines, pursuant to Section 404(b) of PL 92-500 for the purpose of providing guidance to be applied

---

[1] Johnson, E. E. and Johnson, J. C., Identifying and Prioritizing Locations for the Removal of In-Place Pollutants. Washington, D.C.: Office of Water Planning Standards, U.S. Environmental Protection Agency.

in evaluating proposed discharge of dredged or fill material in navigable waters.[1] The guidelines are applicable to all activities involving the discharge of dredged or fill material in navigable waters. Such discharges are unlawful except when in compliance with permits issued by the Secretary of the Army.[2] These guidelines are applicable to all Federal projects or activities.

Purpose of the Study

The U.S. Army Corps of Engineers, Fort Worth District, Texas, in connection with the proposed Trinity River Project, collected information on bottom sediment quality in the Trinity River. The proposed Trinity River Project is a multiple purpose project consisting of four physically interrelated features: the Dallas Floodway Extension and the West Fork Floodway for flood control in the Dallas-Fort Worth Metropolitan Area; Tennessee Colony Lake for lower basin flood control, upper basin water supply, navigation, and hydroelectric power; and the Multi-Purpose Channel for flood control from Fort Worth to Trinity Bay and navigation from Fort Worth to the Houston Ship Channel. Another purpose of the proposed project is recreation and fish and wildlife conservation. The project would also provide river bank stabilization and economic redevelopment benefits. The primary objectives of this study are to (1) develop preliminary data on the quality of river water and bottom sediments in various planning sub-areas of the Trinity River[3] and (2) determine the mobility of various contam-

---

[1] "Navigable Waters Discharge of Dredged or Fill Material," Federal Register, Vol. 40, No. 173, 5 September 1975.

[2] "Permits for Activities in Navigable Waters or Ocean," Federal Register, Vol. 40, No. 144, 25 July 1975.

[3] Planning Sub-area 5, from Beach Street in Fort Worth to confluence of the East Fork of the Trinity (CRM 551-460); Planning Sub-area 4, from the East Fork of the Trinity to SH 31 at Trinidad (CRM 460-392); Planning Sub-area 3, from SH 31 to the headwaters of Lake Livingston (CRM 392-183); and Planning Sub-area 2, from the headwaters of Lake Livingston to Trinity Bay (CRM 183-0).

inants when bottom sediments are mixed with the river water under simulated dredging conditions.

The work described in this report was performed under contract number DACW 63-76-C-0140, entitled "Trinity River Bottom Sediment Reconnaissance Study," between the Fort Worth District Corps of Engineers and the University of Texas at Arlington. This report contains the field and laboratory results.

Scope

Water and bottom sediment samples were collected from 13 sites in the Trinity River. The criteria for selecting these sites were developed and discussed in the report "Phase I - Plan of Work."[1] Many physical, chemical, and biological tests were conducted on (1) filtered and unfiltered river water, (2) filtered and unfiltered elutriates, and (3) bottom sediments. The test procedures were also outlined in the report "Phase I - Plan of Work."

Report Organization

This report includes the major criteria that were utilized for selection of 13 sampling sites, summary of sampling sites, laboratory test procedures, important results and discussion, and recommendations. The bulk of the results, including the physical and biological conditions of the sites sampled, meteorological data, river stage and discharge data, and field and laboratory results, are presented in several appendices of this report.

---

[1] "Trinity River Bottom Sediment Reconnaissance Study Phase I - Plan of Work," prepared for the Fort Worth District Corps of Engineers by the University of Texas at Arlington, Contract No. DACW 63-76-C-0140, November 1976.

SAMPLING SITES, AND FIELD AND LABORATORY MEASUREMENTS

Sampling Sites Selection Criteria

Thirteen sampling sites were selected for water and bottom sediment samples from the Trinity River. In order to select these sampling sites, a procedure was developed which utilized the following basic criteria for site selection:

1) Municipal and industrial wastes discharged
2) Land use activity in the watershed: urban, pasture, agricultural, forest, and others
3) Velocity profiles in the river
4) Proposed channel alignment and lock and dam sites
5) Effects of major tributaries
6) Geological formations
7) Effects of reservoirs
8) Landmarks and accessibility
9) Existing U.S. Geological Survey gauging stations
10) Existing Texas Water Quality Board sediment monitoring stations

A detailed literature search was conducted to establish data on each of the above criteria. A rationale was developed for selection of the sampling sites. The procedure and rationale used for selection of the sampling sites, the factors influencing the quality of the bottom sediments, and descriptions of the 13 selected sampling sites were discussed in the report "Phase I - Plan of Work." The selected sampling sites represented typical conditions associated with pollution resulting from municipal and industrial waste discharges, urban runoff, and drainage from agricultural areas. Factors such as existing Texas Water Quality Board (TWQB) sediment monitoring stations, U.S. Geological Survey (USGS) gauging stations, accessibility to the sampling sites, and existing landmarks were also given consideration.

Sampling Sites

A summary of the 13 sampling sites is shown in Table 1. The entry points, landmarks, proposed Corps lock and dam locations with respect to the proposed sites, and general descriptions of the sites are summarized in Table 1. These sites are shown on Figure 1. Complete descriptions of sampling sites, photographs, and maps are presented in Appendix B.

All the proposed sampling sites were scouted approximately 2 to 4 weeks prior to sampling to determine the accessibility. In many cases, access to the site was possible only by crossing private property. Contacts were made with property owners and sampling activity was coordinated through them. In some cases the proposed site location could not be reached because of an obstruction or hazardous condition in the river. In such cases, an alternate sampling site near the proposed location was used.

Field and Laboratory Measurements

At the time that each sampling site was scouted water samples were collected from the nearest bridge to start the Daphnia magna culture on site water. This culture was later used in the static bioassay on site water and elutriates.

All bottom sediments and river water samples were obtained from a boat. The following is a summary of the data collected during sampling operations and later in the laboratory:

1) Meteorological conditions such as the cloud cover, wind, temperature, and precipitation were noted during the sampling operations. The recorded meteorological data was also obtained from the weather stations in the vicinities of the sampling sites. Precipitation data for a period of six days preceding the dates of sampling, and maximum, minimum, and average temperature values for the sampling dates were obtained.

2) River stage and discharge information was obtained from the U.S. Geological Survey Office in Fort Worth.

TABLE 1. SUMMARY OF SAMPLING SITES

Sampling Site No.	Planning* Sub-area	Corps River Mile	Channel Mile	Accessibility Landmarks & Bridges	USGS Gauging Stations	Meteorological Stations	Proposed Lock & Dam Sites	Predominant Land Use	Relation to the Originally Proposed Sampling Sites in "Phase I - Plan of Work"
1	5	540.5	361.8	Handley Ederville Bridge	Upstream 8048000 Downstream 8049500	Benbrook Dam, Roanoke, Boyd, Bridgeport & Decatur	21	Metropolitan Area--Ft.Worth, Hurst, Euless, Bedford	4.0 miles upstream of proposed site 1.
2	5	532.0	357	Arlington Bedford Bridge	Upstream 8048000 Downstream 8049500	Benbrook Dam, Roanoke, Boyd, Arlington & Bridgeport	20	Metropolitan Area--Ft.Worth, Hurst, Euless, Bedford, Arlington	4.5 miles downstream of proposed site 1.
3	5	511.0	342.5	Meyers Road Bridge	Ustream 8049500 Downstream 8057000	Arlington, Roanoke, DFW Airport, Benbrook Dam & Grapevine Dam	19	Metropolitan Area--Ft.Worth, Hurst, Euless, Bedford, Arlington, Irving, Grand Prairie	1.5 miles upstream of proposed site 3.
4	5	506.5	339.8	Loop 12 Bridge	Upstream 8049500 Downstream 8057000	Arlington, Benbrook Dam, DFW Airport, Roanoke and Grapevine Dam	None	Metropolitan Area--Ft.Worth, Hurst, Euless, Bedford, Arlington, Irving, Grand Prairie	1.0 mile downstream of proposed site 4.
5	5	504.5	337.5	Westmoreland Bridge	Upstream 8049500 Downstream 8057000	Arlington Benbrook Dam, DFW Airport, Grapevine Dam, & Carrollton	None	Metropolitan Area of West Dallas	1.5 miles upstream of proposed site 5.
6	5	478.4	315.9	Beltline Road Bridge	Upstream 8057410 Downstream 8062500	DFW Airport, Carrollton, Richardson, Arlington & Grapevine Dam	17	Metropolitan Area of South Dallas	0.5 mile upstream of proposed site 6.
7	5	456.5	302.2	Property of Jim Wishon, Bristol Texas	Upstream 8057410 Downstream 8062500	DFW Airport, Carrollton, Richardson, Arlington & Grapevine Dam	16	Predominantly crop land & pasture	4.5 miles upstream of proposed site 7 A.
8	4	431.5	286	State Highway 85 Bridge	Upstream 8062500 Downstream 8062700	DFW Airport, Bardwell Dam Crandell, Rosser & Avalon	13	Predominantly crop land & pasture	0.5 mile downstream of proposed site 8 A.
9	3	341.0	234.7	Coffield State Prison	Upstream 8062700 Downstream 8065000	Palestine, Longlake, Rosser, Avalon & Bardwell Dam	Tennessee Colony Dam, 10B & 10A	Predominantly pasture & forest	2.0 miles downstream proposed site 9 A.
10	3	313.0	220.9	U.S. Highway 84 Bridge	Upstream 8065000 Downstream 8065350	Longlake Palestine Jewett, Centerville, & Groveton	9	Predominantly pasture & forest	0.5 miles upsteam of proposed site 10A.

TABLE 1. Summary of Sampling Sites (Concluded)

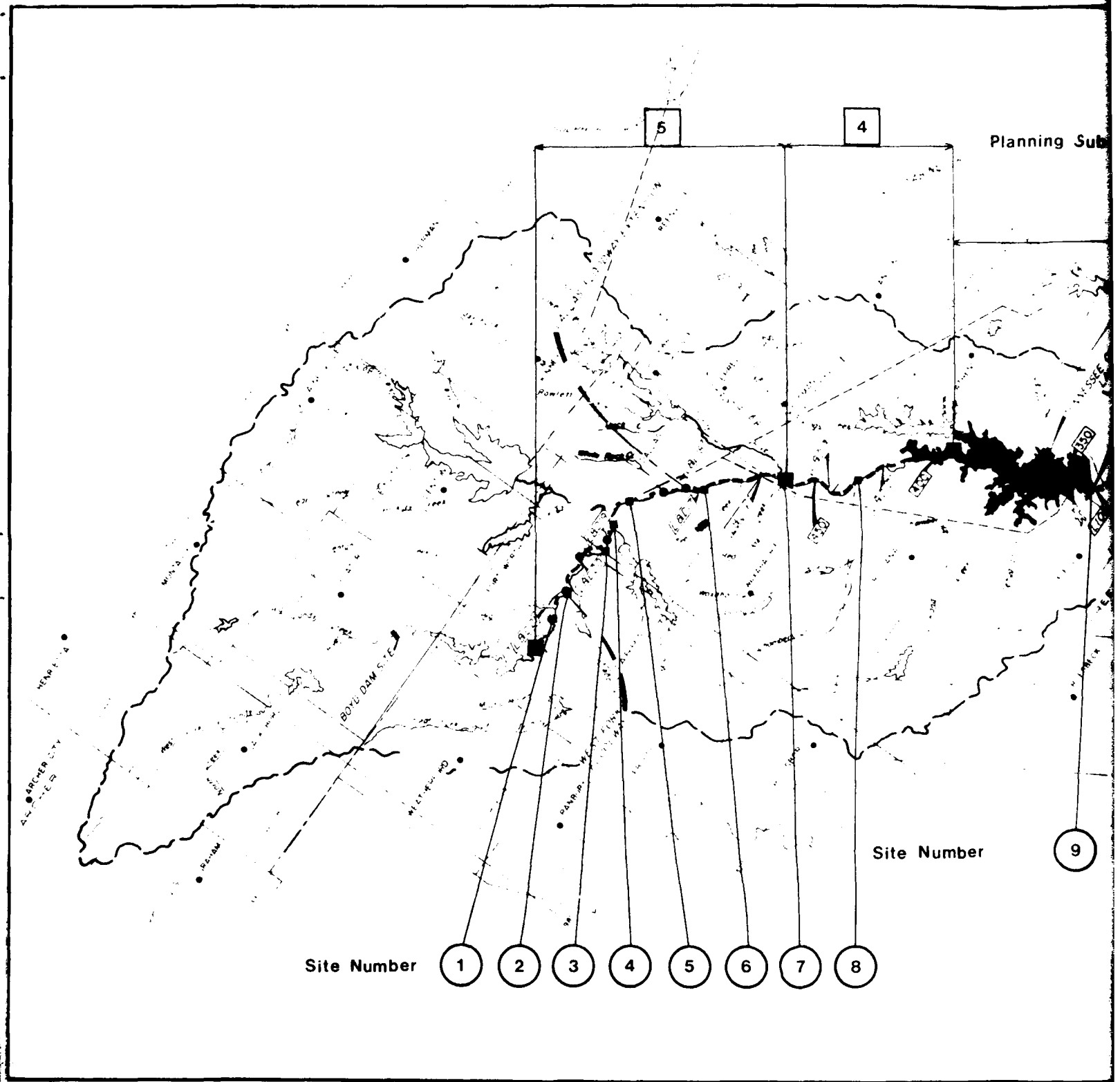
Sampling Site No.	Planning* Sub-area	River Mile	Channel Mile	Accessibility Landmarks & Bridges	USGS Gauging Stations	Meteorological Stations	Proposed Lock & Dam Sites	Predominant Land Use	Relation to the Originally Proposed Sampling Sites in "Phase I - Plan of Work"
11	3	265.0	196.5	State Highway 7 Bridge	Upstream 8065000 Downstream 8065350	Buffalo,Jewett Centerville, Crockett & Lovelady	7	Predominantly pasture & forest	3.5 miles downstream of proposed site 11.
12	3	197.0	145.0	Deep River Water-front Restaurant	Upstream 8065350 Downstream 8066250	Crockett,Love-lady, Madison-ville,Groveton & Lufkin	6	Predominantly forest	3.0 miles downstream of proposed site 12.
13	2	125.0	98.0	Adjacent to the property of Mr. Phillips in Riviera Estates	Upstream 8065350 Downstream 8066250	Coldspring, Crockett,Love-lady, Madison-ville, & Livingston	5A & 5B	Predominantly forest	4.0 miles upstream of proposed site 13.

*5. From Beach Street in Fort Worth to confluence of the East Fork of the Trinity River (CRM 551-460)

*4. From the East Fork of the Trinity to SH 31 at Trinidad (CRM 460-392)

*3. From SH 31 to the headwaters of Lake Livingston (CRM 392-183)

*2. From headwaters of Lake Livingston to Trinity Bay (CRM 183-0)


5
4
Planning Sub
Site Number
9
Site Number
1
2
3
4
5
6
7
8

nning Sub-areas

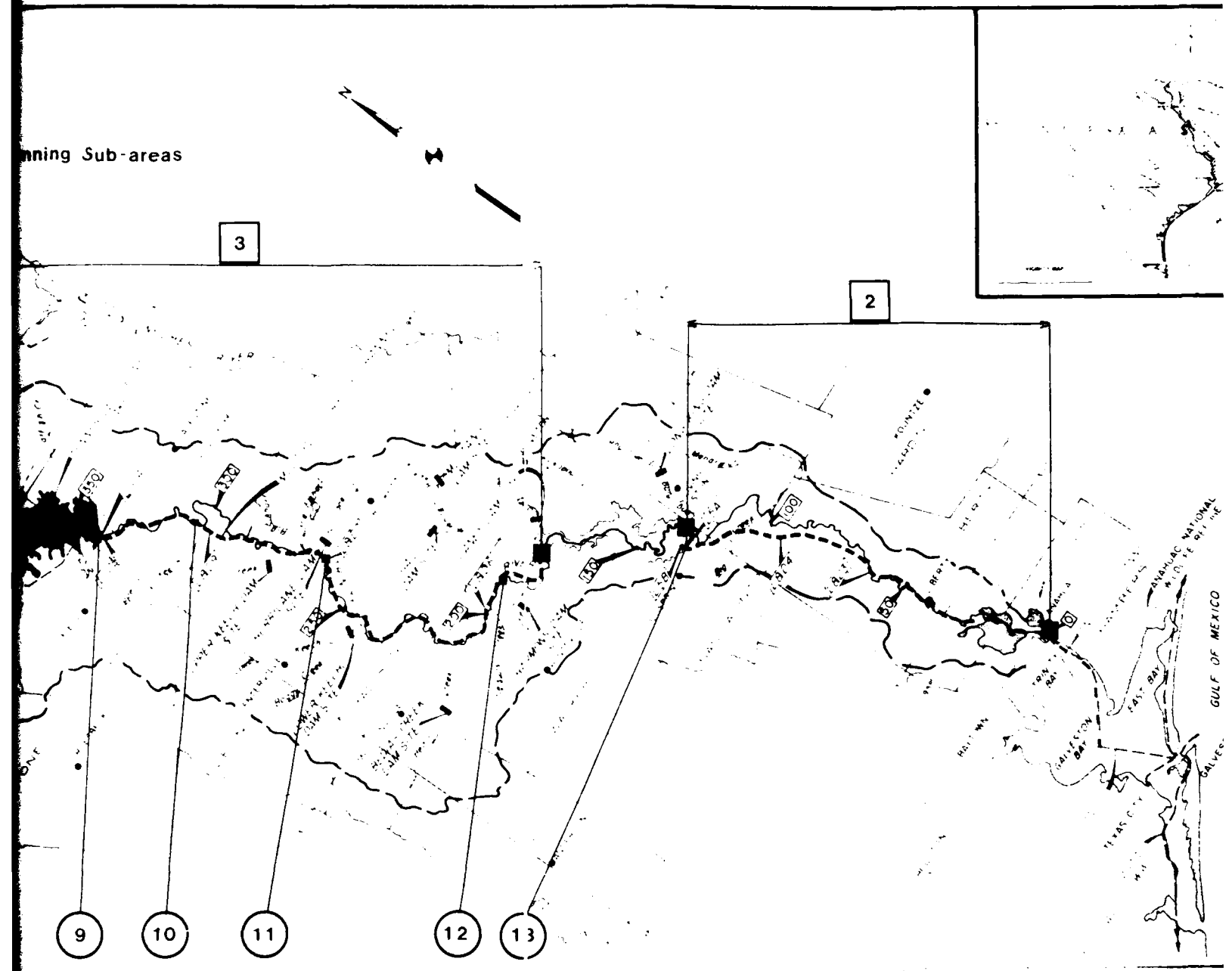


FIGURE 1. PLANNING SUB-AREAS SAMPLING SITES

3) Complete directions for reaching the sites were recorded, and landmarks were noted.

4) The physical and biological conditions at the sampling sites were noted. These included: condition of the river banks, river meanders, scours and deposits along the banks, obstructions, aquatic animals and vegetation, appearance of river, water color, turbidity and floating materials. Many black and white polaroid photographs and 35 mm color slides were taken to record the stream conditions and landmarks.

5) The river velocity at mid-stream section was measured at the time of the sampling operation.

6) Soil samples were collected approximately 200 feet inland from each river bank, sealed and preserved.

7) Water and bottom sediment samples were collected.

8) A number of chemical tests were performed on water and bottom sediments at the sites or immediately after arrival at the laboratory. These included dissolved oxygen, pH, Eh, turbidity, and temperature.

9) A number of laboratory tests were performed on filtered and unfiltered river water, filtered and unfiltered elutriates, and bottom sediments. Detailed procedures were given in the report "Phase I - Plan of Work." Figure 2 summarizes the various tests that were conducted on river water, elutriates, and bottom sediments.

A summary of procedures used during field samplings and laboratory determinations is given in the following section of this report.

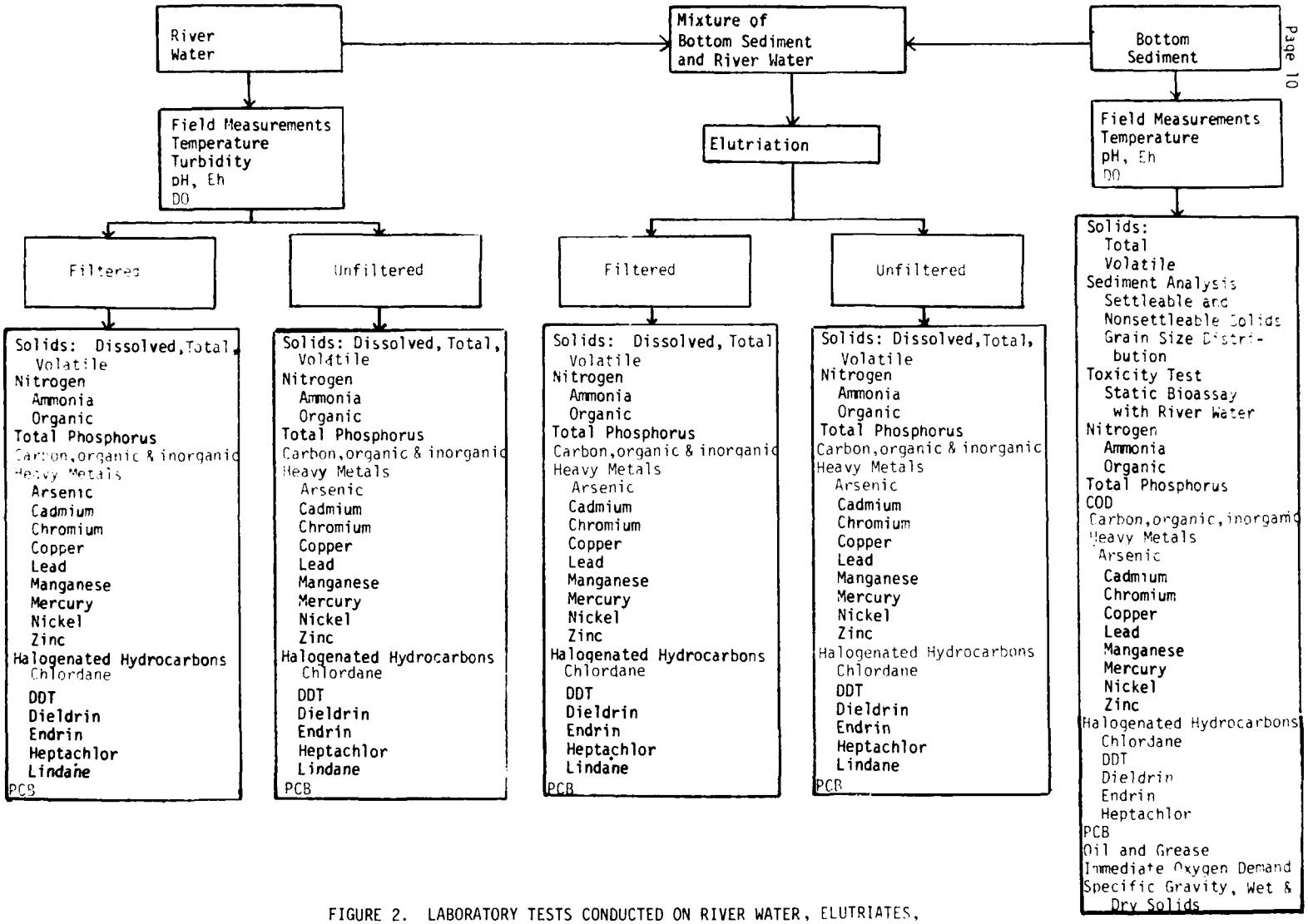


FIGURE 2. LABORATORY TESTS CONDUCTED ON RIVER WATER, ELUTRIATES, AND SEDIMENTS

Sampling and Analytical Procedures

Field sampling, sample preparation, and laboratory procedures utilized during this program were discussed in the report "Phase I - Plan of Work." A summary of the various test procedures is given in Table 2. It was necessary to modify some of the standard procedures in order to accommodate the conditions that arose with different water and bottom sediment samples. Modifications were necessary in grain-size distribution analyses, water and elutriate filtration procedures, heavy metals and pesticide analyses, and static bioassays. These modifications are outlined briefly in Table 2. Sampling equipment used during the program is described in Appendix A.

TABLE 2. FIELD SAMPLING, SAMPLE PREPARATION AND LABORATORY PROCEDURES

PROJECT ACTIVITY	PROCEDURE
Sampling and Field Measurements	
Site Scouting	Each site was scouted 2 to 4 weeks before sampling. The purpose was to obtain suitable avenues of entry into the river near the sampling site. Several contacts were made with property owners when suitable entry was possible across private property. River water samples were collected from the vicinity of the sampling site to develop acclimatized Daphnia magna cultures in the site water for static bioassay.
Water Samples	Water samples were collected from a boat using a 4-liter Alpha Style vertical PVC bottle. Grab samples were collected from 3 locations at each site, normally 1/4, 1/2 and 3/4 width from the bank. The samples were pooled in a container, mixed and placed in 10 one-gallon jars.
Bottom Sediment Samples	Bottom sediment samples were also collected from 3 locations at each sampling site. A 9" x 9" Ponar grab dredge was used. Samples were pooled and 2 one-gallon jars were filled.
Soil Samples from Banks	One soil sample from each bank was collected approximately 200 feet inland. An auger sample approximately 12 inches deep and 6 inches below the ground surface was removed and sealed in a plastic bag.
Meteorological Data	Available meteorological data were obtained from the weather stations in the vicinity of the sampling site. Visual meteorological conditions were also recorded during the sampling period.
River Stage and Discharge Data	The river stage and discharge data for the gauging stations upstream and downstream of the sampling sites were obtained from the U.S. Geological Survey Office in Fort Worth. These data for the desired dates were taken from continuously recording gauges. Some stage measurements were also made from wire weight gauges. Values at the sampling sites were interpolated using these upstream and downstream stage and discharge data.
Stream Velocity	Mid-stream velocity measurements were made with a Teledyne-Gurley-Price current meter. The current meter was lowered to approximately 0.6 x depth from the water surface.
Field and Laboratory Measurements	
pH	Most of the laboratory measurements were made within 2 to 8 hours after sample collection. pH was measured at the site and in the laboratory as soon as the samples were brought in.
Eh (mv)	Eh measurements were made in the laboratory within 2 to 8 hours after sample collection.
Dissolved Oxygen (mg/l)	Dissolved oxygen in river water was fixed at the site for later titration in the laboratory. Also, dissolved oxygen in river water and bottom sediment was measured in the laboratory using a DO meter.
Turbidity (JTU)	Turbidity in JTU was measured using a colorimeter.
Temperature	Temperature was measured at the site.
Sample Preparation	
Elutriation	The bottom sediment and river water were mixed in the ratio of 1:4 by volume and shaken vigorously for 30 minutes on an automatic shaker at about 100 excursions per minute. If an anoxic condition (zero dissolved oxygen) was expected to occur at the dredging site, the elutriation was done by replacing air in the flask with nitrogen gas. If an anoxic condition was not expected, the elutriation was conducted by bubbling air into the flask. After shaking, the suspension was allowed to settle for one hour and then the supernatant was carefully siphoned.
Filtration	River water and supernatant were centrifuged in glass tubes. After centrifugation, the river water and supernatant were filtered through 1.2 and then 0.45 micron filters using a membrane filter assembly and a suction pump. All filters were soaked and rinsed in demineralized water prior to use.
Bottom sediments	Bottom sediments used for chemical anlayses were first screened through a 10 mesh (2mm) sieve and then homogenized in a Waring blender. Unscreened and unhomogenized bottom sediments were used, however, in elutriation, toxicity tests, specific gravity, and grain size distribution analyses.

TABLE 1. Field Sampling, Sample Preparation and Laboratory Procedures (Continued)

PROJECT ACTIVITY	PROCEDURE
Chemical Tests	
Solids in Water and Elutriates	
Total and Dissolved Solids	A well mixed aliquot of water or elutriate was evaporated on a steam bath in a preignited (550 C for 1 hour) and preweighed dish. The residue was dried at 103 C for 1 hour. From the weight of the residue, the solids content was determined.
Volatile Solids	The dish from above tests was ignited at 550 C for 15 minutes. The loss of weight after ignition gave volatile solids.
Solids in Bottom Sediments	
Total Solids	Total solids in bottom sediments were determined by evaporating and oven drying at 103 C a known weight of wet sample. The dish used was preignited as above. The weight of the residue divided by the wet weight gave the total solids fraction.
Volatile Solids	The volatile solids were determined by igniting the total solids from above in a muffler furnace for 1 hour at 600 C. The loss of weight was volatile solids.
Nitrogen in Water and Elutriates and Bottom Sediments	
Ammonia Nitrogen	The ammonia nitrogen was determined by distilling a known volume of buffered (pH 7.4) sample. The distillate was collected in boric acid. The ammonia nitrogen was determined by titration or Nesslerization.
Organic Nitrogen	The sample remaining in the distillation flask was digested with digestion reagent. The digested solution was diluted and distilled under alkaline conditions using hydroxide and thiosulfate reagent. The distillate was collected in boric acid and organic nitrogen was determined by titration or Nesslerization.
Total Phosphrous	
Water and Elutriates	A known volume of sample was digested on a hot plate with sulfuric acid and potassium persulfate. After digestion, the sample was diluted and neutralized. Phosphorus was determined colorimetrically by the Ascorbic Acid Method.
Bottom Sediment	A suitably sized sample was digested with magnesium nitrate in the presence of hydrogen peroxide. The digested sample was then extracted with concentrated hydrochloric acid and diluted before filtering through a membrane filter. The filtrate was then treated with sulfuric acid and potassium persulfate and neutralized. Phosphorus concentration was obtained colorimetically by the Ascorbic Acid Method.
Chemical Oxygen Demand (COD) in Bottom Sediment	A known weight of bottom sediment was chemically oxidized by potassium dichromate in presence of sulfuric acid, silver sulfate and mercuric sulfate. The solution was refluxed for 2 hours. The excess dichromate was titrated with ferrous ammonium sulfate.
Specific Gravity	
Wet Sediment	A known volume of unhomogenized bottom sediment was weighed and the approximate specific gravity was calculated from volume and weight results.
Dry Solids	The specific gravity of dry solids was calculated from the wet specific gravity and the percent solids in the sediment
Immediate-Oxygen Demand	The immediate oxygen demand at 5 bottom sediment concentration (by volume) was determined by filling a 300 ml BOD bottle with water sample. The DO of water was measured with a DO meter. Approximately 20 ml of water were removed from the bottle. 15 ml of well homogenized bottom sediment were placed in the BOD bottle. The remaining space was filled with the water. The bottle was shaken vigorously. DO was measured after 15 minutes, and the IOD determined by the difference.
Total Organic Carbon	
Water and Elutriates	A known volume of sample was injected into a Beckman 915A TOC analyzer. The analyzer consists of an inorganic carbon channel [150°C, to analyze CO_3, etc.] and an organic channel [905°C]. The detector was an 865 infrared analyzer. The samples were compared against standards.

TABLE 2. Field Sampling, Sample Preparation and Laboratory Procedures (Continued)

PROJECT ACTIVITY	PROCEDURE
Total Organic Carbon (Continued)	
Bottom Sediment	A known weight of sediment was diluted to 100 ml in a volumetric flask. The TOC procedure was the same as for liquids.
Heavy Metal (Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Mercury, Nickel, and Zinc)	
Water and Elutriates	All metals except mercury were done by EPA procedures for total metals using a Perkin-Elmer 403 with a 2100 HGA furnace. The samples were digested using concentrated nitric acid and evaporating to a low volume. They were brought back to the original volume for analysis. Concentration of mercury was determined by cold vapor technique.
Bottom Sediments	A quantity of dry sediment was digested to near dryness with concentrated nitric acid, diluted to 100 ml with 1:1 nitric acid, then analyzed in the same manner as the liquid sample.
Pesticides and Herbicides (Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Lindane and PCB)	
Water and Elutriates	The EPA Pesticides Manual was employed as the reference. 500 to 1000 ml of sample were measured using a graduated cylinder and extracted in a separatory funnel with a 15% methylene chloride-85% hexane mixture. The extract was filtered through sodium sulfate [anhydrous]. The resulting filtrate was stored in amber bottles until concentration and Florsil cleanup were accomplished. The concentrated samples were injected and quantitated against standards using gas chromatography.
Bottom Sediments	The sample was air dried for 3 to 7 days, depending upon moisture content. A quantity was weighed, and about 50 gms of anhydrous sodium sulfate were added to dry the sample. The resulting cake was ground to face powder consistency, and extracted in a Soxhlet extractor with 15% CH_2Cl_2-85% hexane. The resulting extract was treated as the extract for liquid sample.
Oil and Grease in Bottom Sediment	A known quantity of sample was weighed. Concentrated hydrochloric acid, hydrogen peroxide, and anhydrous magnesium sulfate were added. The resulting sample was ground to face powder consistency and extracted with trichlorotrifluoroethane in an extractor. The extract, in trichlorotrifluoroethane, was poured into a preweighed flask, evaporated on an 80°C water bath, and weighed.
Static Bioassay	Static bioassays were conducted on 6% and 20% filtered and centrifuged elutriates. Filtered and centrifuged river water was used as control. 200 ml aliquots of prepared elutriates and controls were placed in 250 ml beakers. A desired number of young Daphnia magna previously developed on site water, was introduced into each test beaker. The organisms were fed a standard Daphnia diet.* The test temperature was 18°C, with 14 hours of light and 10 hours of darkness. The mortality data was recorded after two hours and then after every 12 hours of exposure throughout the 96-hour test period. Ammonia nitrogen and dissolved oxygen, turbidity, pH and specific conductance measurements were made prior to introduction of D. magna. After completion of the test, ammonia nitrogen and dissolved oxygen measurements were also conducted on cultured water.
Settleable and Nonsettleable Solids	Nonsettleable solids in the bottom sediments were determined by mixing bottom sediment and river water in ratio 1:4 by weight. The content was settled overnight in a graduated cylinder. The volume of the settled solids and supernatant was recorded. The supernatant was tested for suspended solids using a Gooch crucible predried at 103°C for 1 hour. Nonsettleable solid content was calculated from the result.

*The standard Daphnia diet contained the following: 1 gm fresh yeast, 1 gm granular protein food suitable for fresh water trout, 1 gm vegetable food, all blended with 500 ml of distilled water and then settled for 1/2 hour. 100 ml of supernatant were discarded. The remaining mixture was frozen. The food was brought to room temperature before feeding.

TABLE 2. Field Sampling, Sample Preparation and Laboratory Procedures (Concluded)

PROJECT ACTIVITY	PROCEDURE
Grain Size Distribution	Wet sediment samples were tested for determination of the particle size distribution using standard soil mechanics laboratory procedures. After the sample was drained of excess water, the sample was wet sieved through U.S. Bureau of Standards Sieves numbers 10, 20, 40, 100 and 200. After drying, the material passing the No. 100 sieve, was ground to pass through a No. 200 sieve for hydrometer testing. A representative sample of approximately 50 gms of the fine soil was treated with 10 sodium hexa-metaphosphate solution or leached by centrifuging to disperse the grains. Distilled demineralized water was added to the sample in a clean graduated cylinder and the volume was brought up to 1000 cc. This suspension was mixed by repeated inversions, after which the cylinder was placed in a constant temperature water bath. At appropriate times, hydrometer readings were taken to determine solids in suspension at recorded levels below the original suspension surface. Using the data of corresponding readings of the hydrometer in a control cylinder and a Casagrande nomograph, points were developed to plot the samples' grain size distribution curves. Detailed procedure is given in the report "Phase I - Plan of Work."

RESULTS AND DISCUSSION

The field and laboratory data collected during this program are detailed in Appendices B, C, D, E, F, G, and H. A brief discussion and summary of results is provided in this section of the report.

General

The extraction of various constituents in the elutriate largely depends upon diagenetic mobilization processes such as solution, ion exchange, and desorption. The extent to which elements are mobilized is governed largely by the redox potential (Eh) and the pH of the sediments, which in turn are controlled by the organic content and oxygen supply to the sediments. The availability of oxygen during mixing influences the extraction and concentrations of various constituents in the elutriate. Higher trace metals concentrations were found in elutriates of reduced sediments than those of oxidized sediments.[1] Ammonia nitrogen was also found in anaerobic sediments in soluble state and was released instantly into the dredging or disposal site. Manganese and phosphorus from anaerobic sediments were also found in high concentrations in elutriate.

When anaerobic bottom sediment is mixed with oxygenated water from dredging or disposal site waters, the Fe(II) present in anaerobic sediment precipitates as Fe oxides and hydroxides. Iron oxides and hydroxides efficiently remove trace metals and phosphate from solution.[2] However, some

---

[1] "Selective Analytical Partitioning of Sediments to Evaluate Potential Mobility of Chemical Constituents During Dredging and Disposal Operations," Environmental Effects Laboratory, US Army Engineers Waterway Experiment Station, Vicksburg, Mississippi, Technical Report D-76-7, December 1976.

[2] Lee, G. F., "Role of Hydrous Metal Oxides in the Transport of Heavy Metals in the Environment," Proceedings, Symposium on Heavy Metals in the Environment, Vanderbilt University, Nashville, Tennessee, 1973.

investigators have suggested that the reduction of hydrous oxides in sediments may release adsorbed trace metals into solution, increasing their concentrations in the elutriate.[3]

The laboratory results of the 13 sampling sites indicated that the bottom sediments from Planning Sub-areas 5, 4, and 3 were anaerobic. The elutriation results did not show any pattern that could be used in predicting the release of constituents from sediments into the elutriates. The release of constituents from the sediments into the environment greatly depended upon the physical and chemical quality of the sediments. Some of the specific findings are discussed below:

DO, Eh, and pH

All living organisms are dependent upon oxygen in one form or another for their metabolic processes. For a diversified warm water biota, the DO concentration should be above 5 mg/l. The measured DO concentrations in the Trinity River during this program ranged from 4.2 mg/l to 11.8 mg/l.

All bottom sediments except those from Planning Sub-area 2 were anaerobic. Eh varied from -360 mv to -15 mv in Planning Sub-areas 5, 4, and 3. The lower values of Eh indicate higher concentrations of reductants (organic matter) in bottom sediment. DO, pH, and Eh results for the 13 sampling sites are given in Appendix C. A summary of the measured values is given in Table 3.

---

[3]Duchart, P., Calvert, S. E., and Price, W. B., "Distribution of Trace Metals in the Pore Water of Shallow Water Marine Sediments," Limnology and Oceanography, Vol. 18, 1973.

TABLE 3. SUMMARY OF pH, DO, AND Eh MEASUREMENTS

Planning Sub-area	CRM	River Water pH	Bottom Sediments pH	Average DO of River Water mg/ℓ	Average Eh of Bottom Sediments mv
5	551-460	7.4-7.7	6.8-7.3	5.5	- 171
4	460-392	7.6	7.1	6.7	- 130
3	392-183	7.1-7.7	7.0-7.1	7.8	- 88
2	183-0	8.1	7.7	11.8	+ 135

The following trends may be observed in the above table:

(1) The average DO concentration gradually increased from Planning Sub-areas 5 to 2, indicating less organic pollution in the lower reaches.

(2) The Eh of the bottom sediments gradually increased from Planning Sub-areas 5 to 2, indicating lower concentrations of reductants in the bottom sediments.

(3) pH of river water and bottom sediments remained within the physiological range of pH 6.5 to 7.5.

Immediate Oxygen Demand

The immediate oxygen demand (IOD) is a measure of the oxygen requirement of oxidizable substances such as ferrous iron, sulfite, sulfide, aldehydes, and ketones that are present in the bottom sediments and could be released into the water during dredging operations. The IOD tests were conducted with samples that had been frozen and then brought to room temperature prior to use and therefore may not be a true representation of IOD. In our opinion, anaerobic or low DO (~5 mg/l) conditions will develop in all Planning Sub-areas except 2 when bottom sediments are disturbed during dredging operations. IOD values are detailed in Appendix D. Major IOD results are summarized in Table 4.

TABLE 4. SUMMARY OF IOD RESULTS

Planning Sub-area	CRM	Average Measured IOD, mg/ℓ	Remarks
5	551-460	4.4	Anaerobic conditions will probably result when bottom sediments are mixed with river water during dredging operation.
4	460-392	1.8	Anaerobic or low DO (<5mg/ℓ) conditions will probably result when bottom sediments are mixed with river water.
3	392-183	3.2	Low DO (<5mg/ℓ) conditions will probably result when bottom sediments are mixed with river water.
2	183-0	0.5	Mixing of bottom sediments with river water will not result in a significant depression of the DO concentration.

Solids

Dissolved solids are of potential importance because of their chemical makeup and effects on water systems. Organic dissolved solids exert biochemical oxygen demand and inorganic dissolved solids may cause alkalinity, acidity, hardness, and salinity. High dissolved solids in water can produce an unfavorable taste. For these reasons, the recommended upper limit for dissolved solids in potable water is 500 mg/l.

Volatile solids determinations are indicative of the total organic matter present in a sample. The upper limit of volatile solids concentration in bottom sediments recommended by the EPA for Region VI is 80,000 mg/kg. All solids results are presented in Appendix D. A brief discussion is given below:

Water and Elutriates

The dissolved solids concentrations in the Trinity River water samples ranged between 110 mg/l and 630 mg/l. For most samples, the value was greater than 500 mg/l, indicating poor water quality. The dissolved solids in elutriates

did not increase over those in the river water. In fact, there was a reduction in dissolved solids in the filtered elutriates from some of the sampling sites in Planning Sub-areas 3 and 2. This indicates that elutriation may remove some of the dissolved matter from solution and may improve the water quality with respect to dissolved solids. The amount of removal, however, depends upon the adsorptive capacity of the sediment. Important solids results are summarized in Table 5.

Table 5. SUMMARY OF SOLIDS RESULTS IN WATER AND ELUTRIATES

Planning Sub-area	CRM	Average dissolved solids concentration in river water, mg/ℓ	Average increase in total solids in elutriates over river water, mg/ℓ	Average increase in dissolved solids in elutriates over river water, mg/ℓ
5	551-460	550	830	80
4	460-392	380	1,220	340
3	392-183	340	1,290	50
2	183-0	180	3,170	- 10

Bottom Sediments

The total solids in the bottom sediments, as collected using a Ponar dredge, varied from 30 to 74 percent. The volatile solids in bottom sediments also varied greatly depending upon the presence of organic matter, carbonates, and bicarbonates. Volatile solids gradually decreased from Planning Sub-areas 5 to 2 indicating less organic matter in bottom sediments from the lower reaches of the river. Solids results are summarized in Table 6.

TABLE 6. SUMMARY OF SOLIDS RESULTS IN BOTTOM SEDIMENTS

Planning Sub-area	CRM	Average Total Solids %	Average Volatile Solids % Dry Wt.
5	551-460	50	7.6
4	460-392	71	4.1
3	392-183	50	4.7
2	183-0	29	1.4

Nitrogen

Nitrogen is an essential constituent of protein in all living organisms. It undergoes changes on decomposition from complex proteins through amino acids to ammonia, nitrite, and nitrate. A high concentration of organic nitrogen is an indication of recent pollution while high ammonia nitrogen indicates an active decomposition condition. In polluted waters and bottom sediments, nitrogen may be present in many forms.

For aquatic life, organic nitrogen, amino acids, and ammonia nitrogen may inhibit biological growth, whereas nitrates stimulate phytoplankton growth. Ammonia nitrogen is found to have toxic effects upon all forms of aquatic life. The ability of hemoglobin to combine with oxygen is greatly impaired in fish at 1 mg/l ammonia nitrogen level, and fish may suffocate. The EPA recommends an upper limit of 0.02 mg/l for ammonia nitrogen in domestic water supplies. This limit was exceeded in all water samples tested. Nitrogen results are detailed in Appendix D.

Water and Elutriates

A summary of nitrogen results in water and elutriates is given in Table 7.

TABLE 7. SUMMARY OF NITROGEN RESULTS IN WATER AND ELUTRIATES

Planning Sub-area	CRM	Average AN conc. in river water mg/ℓ	Average increase in AN conc. in elutriates over that in river water mg/ℓ	Average increase in AN conc. in filtered elutriates over that in filtered river water mg/ℓ	Average ON conc. in river water mg/ℓ	Average increase in ON conc. inelutriates over that in river water mg/ℓ	Average increase in ON conc. in filtered elutriates over that in filtered river water mg/ℓ
5	551-460	7.5	11.8	11.5	2.8	4.1	0.1
4	460-392	8.6	- 4.9	- 3.5	1.5	1.3	0.0
3	392-183	1.5	- 0.4	- 0.3	1.3	2.3	- 0.1
2	183-0	0.2	- 0.1	cannot be determined	1.3	0.8	- 0.2

Note: Negative values indicate decreases.

Ammonia nitrogen (AN) concentrations in water samples tested from the Trinity River varied from 9.9 mg/l to 0.1 mg/l. Most of the AN was in the dissolved form, while the organic nitrogen (ON) generally remained in particulate form. The following trends may be observed from the data in Table 7:

(1) The AN concentrations increased significantly in the elutriates from Planning Sub-area 5 and increased only slightly or decreased in elutriates from Planning Sub-areas 4, 3, and 2.

(2) ON concentrations generally increased in unfiltered elutriates, but there was a significant decrease in ON concentrations after filtration.

(3) There was slight increase in ON concentration in filtered elutriates over filtered river water in Planning Sub-area 5. However, there was consistent decrease in dissolved ON concentrations in other planning sub-areas.

Bottom Sediments

The recommended EPA limit for total Kjeldahl nitrogen (TKN) in bottom sediments is 1000 mg/kg. AN in the bottom sediments was in the soluble form. Most of it was immediately released into the water during elutriation procedures. ON appeared to be in the particulate form. AN, ON, and TKN concentrations were highest in Planning Sub-area 5 and gradually decreased downstream as is shown in

Table 8. This indicates that the quality of the bottom sediments was improved in the lower reaches of the river.

TABLE 8. SUMMARY OF NITROGEN CONCENTRATIONS IN BOTTOM SEDIMENTS

Planning Sub-area	CRM	Average AN, mg/kg dry wt.	Average ON mg/kg dry wt.	Average TKN, mg/kg dry wt.
5	551-460	275	1,600	1,872
4	460-392	53	430	483
3	392-183	27	640	664
2	183-0	2	350	352

Total Phosphorus

Phosphorus does not occur in its free state in nature but is found as phosphates, and in organic forms. In these forms it exists in solution, in particulates of detritus, and in aquatic organisms. Phosphate is an essential nutrient for plant growth. The desirable upper limit of total phosphorus in rivers that enter lakes or reservoirs is less than 0.05 mg/l. This limit is based upon the phosphorus requirements of different species of algae in reservoirs. Total phosphorus concentrations in river water, elutriates, and bottom sediments are detailed in Appendix D. A summary of results is given in Table 9.

Water and Elutriates

Phosphorus concentrations gradually decreased in river water from Planning Sub-areas 5 to 2. Elutriation removed some phosphorus from solution. Also, there was a decrease in total dissolved phosphorus concentrations in filtered elutriates. The amount of reduction of phosphorus in elutriates, however, depended greatly upon the adsorptive capacity of the sediment.

TABLE 9. SUMMARY OF TOTAL PHOSPHORUS CONCENTRATIONS IN WATER AND ELUTRIATES AND BOTTOM SEDIMENTS

Planning Sub-area	CRM	Average total P concentration in river water mg/ℓ	Average increase in total P in elutriates over that in river water mg/ℓ	Average total P increase in filtered elutriates over that in filtered river water mg/ℓ	Average total P concentration in bottom sediments mg/kg dry wt
5	551-460	5.2	-0.2	-2.1	2,064
4	460-392	3.9	-2.0	-3.4	55
3	392-183	1.3	-1.2	-0.9	299
2	183-0	0.2	-0.1	0	43

Note: Negative values indicate decreases.

Bottom Sediments

The total phosphorus concentrations decreased from Planning Sub-area 5 to 2. In general, high phosphorus concentrations were measured downstream from large wastewater treatment plants. (See Appendix B for point source discharge data.)

Carbon and Chemical Oxygen Demand

Total organic carbon (TOC) provides a measure of organic matter present in water and bottom sediments. Chemical oxygen demand (COD), however, provides a measure of the oxygen equivalent to that portion of the organic matter in a sample that is susceptible to oxidation by a strong chemical oxidant. Carbon and COD results are detailed in Appendix D.

Water and Elutriates

A major portion of the organic carbon was in an insoluble state. The unfiltered elutriates tested exhibited high organic carbon concentrations, particularly in Planning Sub-area 5. However, the elutriates tested showed only slightly higher organic carbon concentrations in filtered elutriates than in

filtered river water indicating that the major portion of the organic carbon was in a particulate form. TOC concentrations decreased from Planning Sub-areas 5 to 2. A summary of TOC results is given in Table 10.

TABLE 10. SUMMARY OF TOC CONCENTRATIONS IN WATER AND ELUTRIATES

Planning Sub-area	CRM	Avg. concentrations of total organic carbon in river water, mg/ℓ	Avg. increase in TOC concentrations in elutriates over river water, mg/ℓ	Avg. increase in TOC concentrations in filtered elutriates over filtered river water, mg/ℓ
5	551-460	33	30	8
4	460-392	26	- 11	0
3	392-183	24	14	2
2	183-0	18	22	- 3

Note: Negative values indicate decreases.

Bottom Sediments

High COD and organic carbon concentrations were measured in the bottom sediments. The EPA recommended limit for COD for Region VI is 50,000 mg/kg. The COD values in bottom sediments from several sampling sites in Planning Sub-area 5 exceeded this limit. TOC and COD values generally decreased from Planning Sub-areas 5 to 2. Several very useful relationships appear to apply to the volatile solids (VS), TOC, COD. and total organic nitrogen (TON) results. The COD, TOC, and VS results and ratios of several of these constituents in bottom sediments are summarized in Table 11. The following relationships may be obtained from the ratios given in Table 11.

(1) The VS to COD ratio is in the range 1.4 to 4.7 with generally lower values in Planning Sub-area 5.

(2) The COD to TOC ratio lie in the range 1.3 to 2.9.

(3) The organic sludge index (OSI) which is a product of TOC and TON values appears to be higher in the highly polluted reaches of the river. Larger values of OSI in Planning Sub-area 5 were found below major point source discharges. (See Appendix B for point source discharges.)

TABLE 11. RATIOS OF VARIOUS CONSTITUENTS THAT ARE INDICATORS OF ORGANIC POLLUTION IN BOTTOM SEDIMENTS

Planning Sub-area	Sampling Site (CRM)	COD mg/kg	TOC mg/kg	VS mg/kg	TON mg/kg	$\frac{VS}{COD}$	$\frac{COD}{TOC}$	(TON x TOC) x 10^6
5	1(540.5)	8,140	4,160	14,000	220	1.7	2.0	0.92
5	2(532.0)	20,900	14,300	45,600	1,250	2.2	1.5	17.88
5	3(511.0)	4,200	3,270	9,850	190	2.3	1.3	0.62
5	4(506.5)	61,800	28,790	111,000	2,220	1.8	2.1	63.91
5	5(504.5)	76,520	26,230	121,000	2,980	1.6	2.9	78.17
5	6(478.4)	110,000	46,500	157,000	3,530	1.4	2.4	164.15
5	7(456.5)	24,700	11,000	75,700	810	3.1	2.3	8.91
Average	-	43,750	19,180	76,310	1,600	2.0	2.1	47.79
4	8(431.5)	9,450	5,440	41,400	430	4.4	1.7	2.34
3	9(341.0)	21,900	9,900	68,300	770	3.1	2.2	7.62
3	10(313.0)	15,900	8,360	43,000	560	2.7	1.9	4.68
3	11(265.0)	9,780	3,930	30,400	270	3.1	2.5	1.06
3	12(197.0)	23,600	10,700	44,500	950	1.9	2.2	10.17
Average	-	17,800	8,220	46,550	640	2.7	2.2	5.88
2	13(125.0)	3,170	2,370	14,800	350	4.7	1.3	0.83

Heavy Metals

All living systems are affected by heavy metals to varying extents. Heavy metals are the most insidious pollutants because of their nonbiodegradable nature. Only a few metals are completely nontoxic at any level. These metals could be harmful if they unbalance or displace the essential levels in the ecosystem. Some heavy metals are of concern because of their bioaccumulation potential in biological systems. The results of the heavy metals are given in Appendix D. A summary of heavy metal results is given in Tables 12 and 13.

Water and Elutriates

The test results indicated that managanese, chromium, and lead were the pollutants present in exceedingly high amounts in river water (See Table 12). Manganese values exceeded the 1976 EPA water quality criteria in all planning sub-areas. It should be noted, however, that the ambient manganese concentrations are normally high in the Trinity River Basin.

Elutriation generally increased manganese, arsenic, and zinc concentrations. Concentrations of many other heavy metals varied widely in the elutriates. The release of heavy metals into the water on elutriation was probably due to many causes such as the adsorptive and cation exchange capacity of the bottom sediments, the extent to which the sediments contained various elements, and the oxidized or reduced state of the sediments.

The metals appeared to be adsorbed onto particulates and therefore were removed in significant amounts by filtration. Arsenic was removed almost entirely by filtration.

Many heavy metals concentrations, especially in the upper reach of Planning Sub-area 5, were found higher in filtered river water and filtered elutriate than in unfiltered river water and unfiltered elutriate. High concentrations in

TABLE 12. RANGE OF CONCENTRATIONS OF HEAVY METALS IN FILTERED AND UNFILTERED RIVER WATER AND ELUTRIATES IN VARIOUS PLANNING SUB-AREAS, mg/l

Heavy Metals		Planning Sub-area 5 CRM 551-460	Planning Sub-area 4 CRM 460-392	Planning Sub-area 3 CRM 392-183	Planning Sub-area 2 CRM 183-0
Arsenic(As)	URW	<1.5 - 12.0	6.0	5.0 - 12.0	11.0
	FRW	<1.5	<1.5	<1.5	<1.5
	UEL	<1.5 - 46.0	13.0	20.0 - 135.0	210.0
	FEL	<1.5	<1.5	<1.5	<1.5
Cadmium(Cd)	URW	3.6 - 19.5	8.7	4.8 - 9.4	1.8
	FRW	1.8 - 8.6	2.5	<0.1 - 2.5	1.0
	UEL	2.7 - 20.8	9.7	3.8 - 10.2	9.0
	FEL	0.7 - 11.8	<0.1	0.2 - 11.0	0.1
Chromium(Cr)	URW	5.0 - 2,500.0	737.0	275.0 - 825.0	225.0
	FRW	<1.5 - 10.0	<1.5	<1.5	8.0
	UEL	<1.5 - 1,375.0	250.0	337.0 - 550.0	392.0
	FEL	<1.5 - 20.0	10.0	<1.5	5.0
Copper(Cu)	URW	15.0 - 720.0	260.0	160.0 - 600.0	200.0
	FRW	<2.0 - 42.0	5.0	<2.0 - 4.0	5.0
	UEL	8.0 - 1,620.0	440.0	140.0 - 620.0	380.0
	FEL	5.0 - 40.0	39.0	<2.0 - 3.0	6.0
Lead(Pb)	URW	<1.0 - 1,419.0	445.0	110.0 - 11,490.0	110.0
	FRW	<1.0 - 3.0	2.0	<1.0 - 8.1	<1.0
	UEL	1.5 - 1,215.0	284.0	126.0 - 445.0	561.0
	FEL	1.0 - 9.0	2.0	<1.0 - 5.5	1.2
Manganese(Mn)	URW	80.0 - 950.0	125.0	125.0 - 217.0	150.0
	FRW	80.0 - 198.0	172.0	<0.4 - 79.0	5.0
	UEL	119.0 - 2,500.0	1,375.0	1,212.0 - 3,000.0	1,125.0
	FEL	79.0 - 1,003.0	779.0	320.0 - 1,000.0	20.0
Mercury(Hg)	URW	0.2 - 0.6	0.3	<0.05 - 0.4	<0.05
	FRW	0.05 - 0.6	0.4	<0.05 - 0.2	<0.05
	UEL	0.2 - 0.7	0.3	<0.05 - 0.4	<0.05
	FEL	0.05 - 0.6	0.3	<0.05 - 0.3	<0.05
Nickel(Ni)	URW	26.0 - 20,800.0	190.0	60.0 - 1,050.0	105.0
	FRW	7.0 - 300.0	10.0	<7.0 - 10.0	<7.0
	UEL	<7.0 - 565.0	55.0	95.0 - 10,140.0	4,290.0
	FEL	<7.0 - 57.0	42.0	<7.0	<7.0
Zinc(Zn)	URW	10.0 - 215.0	57.0	61.0 - 172.0	81.0
	FRW	<0.05 - 60.0	80.0	10.0 - 40.0	30.0
	UEL	10.0 - 754.0	195.0	111.0 - 330.0	446.0
	FEL	<0.05 - 60.0	20.0	<0.05 - 40.0	<0.05

Note: URW = Unfiltered river water
FRW = Filtered river water
UEL = Unfiltered elutriates
FEL = Filtered elutriates

unfiltered samples are normally expected. The reasons for this discrepancy are not known. Either of the following factors could have caused this discrepancy:

(1) The water samples were collected from three locations at each site. These samples were mixed into a container. Then, several one-gallon jars were filled. Incomplete mixing may have provided variable quality in water samples in different jars and inconsistent results in filtered and unfiltered river water and elutriates.

(2) The water samples were digested with nitric acid. Incomplete digestion and leaching of unfiltered samples may have resulted in lower readings.

Procedures for water sampling after the first three sites in Planning Sub-area 5 were modified. Water samples were thoroughly mixed at the site to insure uniform quality in all jars. Analytical techniques were also modified to insure complete digestion and leaching of strongly adsorbed and bound metals.

Bottom Sediments

Cadmium and lead concentrations exceeded the recommended EPA limits at most of the sampling sites tested (See Table 13). Only in Planning Sub-area 4 and at one site in Planning Sub-area 3 did all the heavy metal concentrations remain below the EPA limits.

Halogenated Hydrocarbons and Polychlorinated Biphenyls

The substitution of a chlorine (or other halogen) atom for a hydrogen atom greatly increases the anesthetic action of a member of the aliphatic hydrocarbons. In addition, the chlorine derivative is usually less specific in its action and may affect other tissues of the body in addition to those of the central nervous system; in many cases the chlorine derivative is quite toxic. Thus, chloroform, in addition to its narcotic qualities, may cause liver, heart, and kidney damage.

As a general rule, the unsaturated chlorine derivatives are highly narcotic but less toxic than the saturated derivatives, thus causing degenerative changes in the liver and kidneys less frequently.

TABLE 13. HEAVY METALS CONCENTRATIONS IN BOTTOM SEDIMENTS IN VARIOUS PLANNING SUB-AREAS (mg/kg)

Planning Sub-area	Sampling Site (CRM)	Arsenic(As)	Cadmium(Cd)	Chromium(Cr)	Copper(Cu)	Lead(Pb)	Manganese(Mn)	Mercury(Hg)	Nickel(Ni)	Zinc(Zn)
5	1(540.5)	1.7	0.6	14	6	18	249	0.2	61	29
5	2(532.0)	3.3	13.4	37	16.5	57	372	0.4	6.7	115
5	3(511.0)	1.6	0.7	18	5.5	24	181	0.2	54	27
5	4(506.5)	4.4	15.3	120	73.5	69.5	372	0.4	18	136
5	5(504.5)	4.6	18.1	110	88.7	66.5	425	0.3	21	188
5	6(478.4)	4.8	17.5	120	159	82.5	489	0.4	15	241
5	7(456.5)	1.3	4.2	9.8	9	17.5	55	2.2*	60	34
Average for Planning Sub-area 5		3.1	10	61	51	48	306	0.6	26	110
4	8(431.5)	2.4	0.7	12	9.8	18	315	0.3	16	29
3	9(341.0)	3.6	14.1	10	49.3	74.5	305	0.3	11	128
3	10(313.0)	1.1	2.2	3	32.5	18	170	0.5	75	33
3	11(265.0)	3.9	1.3	50	16	20.5	239	0.3	7.5	36
3	12(197.0)	0.8	2.2	3	9.3	51	85	0.3	12	65
Average for Planning Sub-area 3		2.4	5.0	16.5	27	41	200	.4	26	
2	13(125.0)	0.6	1.6	1	11.1	32	10	0.2	75	10
EPA Limit (1973)[1]		5	2	100	50	50	-	1	50	75

*May be because of discharge from the East Fork of the Trinity River which enters the river just above this site.

[1]EPA Region VI, 1973.

In dealing with the chlorinated hydrocarbons (pesticides), it must be remembered that a toxic action may result from repeated exposure to concentrations which are too low to produce a narcotic effect, and which, consequently, are too low to give warning of danger. Individual susceptibility is also important when poisoning by this group of solvents is being considered. Pesticide and PCB data was collected on river water, elutriates, and bottom sediments from 13 sites. These results are detailed in Appendix D.

Polychlorinated biphenyls (PCBs), which are primarily used as transformer cooling fluids, are complex mixtures of several similar compounds. The recommended EPA upper limit for PCB concentrations in domestic water supplies is less than 0.002 µg/l. The low limit is largely an attempt to protect aquatic life, since PCBs are highly cumulative (up to 200,000 X). No limit of acceptability has been set for drinking water, since "too little is known about the levels in water, the retention and the accumulation in humans, and the effects of very low rates of ingestion," (EPA 1973b). No PCBs were detected in any of the water, elutriates, or bottom sediments tested.

Halogenated Hydrocarbons and PCBs in Water and Elutriates

Pesticide concentrations were found to be highest in the water samples tested from Planning Sub-area 3. No chlordane was detected in any of the samples tested. Pesticide concentrations in the river water tested are given in Table 14. Elutriation test procedures did not result in any consistent increases or decreases in pesticides concentrations. This variability was probably a result of the different pesticide solubilities in the river water and the varying soil characteristics.

Generally, the sample injections produced clean chromatograms with sharp, well resolved peaks. Pesticide concentrations in filtered samples should, of course, have been lower than those in unfiltered samples. Several data inver-

TABLE 14. RANGE OF CONCENTRATIONS OF PESTICIDES IN RIVER WATER AND ELUTRIATES (µg/ℓ)

Pesticides		Planning Sub-area 5 CRM(551-460)	Planning Sub-area 4 CRM(460-392)	Planning Sub-area 3 CRM(392-183)	Planning Sub-area 2 CRM(183-0)
Chlordane	URW	<0.3	<0.3	<0.3	<0.3
	FRW	<0.3	<0.3	<0.3	<0.3
	UEL	<0.3	<0.3	<0.3	<0.3
	FEL	<0.3	<0.3	<0.3	<0.3
DDT	URW	<0.5 - 9.2	4.4	1.4 - 12.8	17.7
	FRW	<0.5 - 4.9	3.5	0.5 - 3.8	5.9
	UEL	<0.5 - 34.8	11.7	2.2 - 6.3	10.1
	FEL	<0.5 - 9.8	3.5	1.1 - 4.8	1.2
Dieldrin	URW	<0.3 - 58.0	9.4	1.4 - 233.5	1.4
	FRW	<0.3 - 42.2	3.2	0.3 - 6.1	0.9
	UEL	<0.3 - 193.0	8.1	4.4 - 65.5	1.6
	FEL	<0.3 - 26.7	3.2	0.3 - 5.5	0.4
Endrin	URW	<0.3 - 34.5	9.2	30.5 - 326.7	4.0
	FRW	<0.3 - 23.5	1.1	0.8 - 100.6	54.2
	UEL	<0.3 - 33.5	82.0	10.5 - 69.0	53.4
	FEL	<0.3 - 38.5	1.0	0.4 - 56.3	13.6
Heptachlor	URW	<0.3 - 25.2	30.4	2.6 - 135.6	8.5
	FRW	<0.3 - 169.0	5.0	0.3 - 5.9	3.2
	UEL	<0.3 - 299.0	92.4	31.6 - 48.3	111.4
	FEL	<0.3 - 14.1	1.6	0.3 - 22.4	6.7
Lindane	URW	6.6 - 140.0	17.1	2.0 - 7.2	5.8
	FRW	7.8 - 302.0	11.6	1.0 - 13.8	5.1
	UEL	12.5 - 584.0	7.3	5.4 - 8.7	3.8
	FEL	1.8 - 169.0	14.6	1.7 - 8.0	3.8

Note: URW = Unfiltered river water
FRW = Filtered river water
UEL = Unfiltered elutriates
FEL = Filtered elutriates

sions however, did occur. These inversions may be explained by the following observations:

(1) Some of the apparent data inversions are within the limits of accuracy of the technique and should be considered equal.

(2) Filtration may have removed bacteria, adsorptive soils, or oxidizing agents resulting in a slower rate of breakdown of pesticides in filtered samples than unfiltered samples. Consequently, higher concentrations of pesticides were measured in filtered samples.

(3) In some samples, interfering substances that could not be cleaned up produced peaks which masked the pesticide peak.

Bottom Sediments

Pesticide concentrations were found to be highest in the sediments from Planning Sub-areas 5 and 4. No PCBs were detected in any of the bottom sediments tested. Heptachlor and lindane results were masked by an interfering substance that could not be removed by standard cleanup techniques, Florisil, or activated copper. The pesticides results are summarized in Table 15.

Oil and Grease

Oil and grease determinations are important because of the high solubility of halogenated hydrocarbons in the oil and grease. Low levels of oil and grease are in general nontoxic but provide an indication of the overall quality of the bottom sediments. No criteria for oil and grease concentrations in bottom sediments were found for comparison of results. Oil and grease concentrations are given in Appendix D. A summary of the oil and grease determinations is given in Table 16.

TABLE 15. PESTICIDE CONCENTRATIONS IN BOTTOM SEDIMENT SAMPLES, mg/kg

Planning Sub-area	Sampling Site(CRM)	Chlordane	DDT	Dieldrin	Endrin	Heptachlor	Lindane
5	1(540.5)	2.2	3.3	<0.3	0.9	M	M
5	2(532.0)	6.0	30.0	18.0	7.0	M	M
5	3(511.0)	0.2	2.9	0.3	4.7	4.9	0.4
5	4(506.5)	45.0	53.6	0.3	19.0	M	M
5	5(504.5)	47.4	41.8	33.0	17.0	M	M
5	6(478.4)	64.0	39.7	80.0	20.0	M	M
5	7(456.5)	4.4	9.8	176.0	3.0	M	M
Average for Planning Sub-area 5		24.0	26.0	*	10.0	*	*
4	8(431.5)	<0.3	19.9	13.6	15.4	M	M
3	9(341.0)	<0.3	2.9	5.0	6.3	4.3	0.7
3	10(313.0)	<0.3	<0.5	<0.3	<0.3	0.7	0.2
3	11(265.0)	<0.3	5.4	4.1	7.8	9.3	0.2
3	12(197.0)	<0.3	<0.5	0.3	0.3	M	M
Average for Planning Sub-area 3		*	*	*	*	*	*
2	13(125.0)	<0.3	2.0	0.8	20.0	7.2	<0.2

M = Masked by interfering substance peaks.

*Average could not be determined because some concentrations were below detection limits and others were masked by interfering substances.

TABLE 16. SUMMARY OF OIL AND GREASE CONCENTRATIONS IN BOTTOM SEDIMENTS

Planning Sub-area	CRM	Average Oil and Grease, mg/kg dry wt.
5	551-460	3,120
4	460-392	440
3	392-183	880
2	183-0	610

Oil and grease concentrations in bottom sediments from Planning Sub-area 5 were exceedingly high. As noted earlier, this area is grossly polluted due to discharge of waste water treatment plants and suface runoff from urban areas.

Static Bioassay

Ammonia nitrogen appeared to be the limiting factor in growth and survival for Daphnia magna. Mortality was consistently higher in control groups than in elutriates. Replicate tests on unfed and fed organisms on the first three sites showed that an abundant food supply allowed the organisms to survive longer but did not prevent the higher mortality in the control.

The lethal effects of high ammonia nitrogen concentrations were enhanced by the presence of other pollutants. D. magna could tolerate higher concentrations of ammonia nitrogen when other pollutant concentrations were low, while moderate concentrations of ammonia nitrogen proved lethal when other pollutant concentrations were high.

Elutriation consistently improved water for habitation by D. magna. While ammonia nitrogen concentrations were not significantly lowered by elutriation, the elutriation procedures did result in the lowering of enough other pollutant concentrations to affect survival in elutriates. (See Appendix D for pollutant concentration changes in elutriates over river water.)

In filtered samples also, survival was generally greater in elutriates than in controls. Overall, survival was greater in filtered than in unfiltered samples. Ammonia nitrogen determinations on filtered and unfiltered river water and elutriate samples showed that ammonia nitrogen concentrations were not significantly lowered by filtration. The higher survival of D. magna in filtered than in unfiltered samples therefore, is further indication that the effects of ammonia nitrogen are at least partially dependent upon the presence of other pollutants. Static bioassay results are presented in Appendix E. The 96 hour survival percentages are given in Table 17.

The following observations may be made from the results given in Table 17.

(1) Planning Sub-area 5. High mortality in control water from this area showed that the river was unfit for habitation by D. magna and possibly other forms of aquatic life. Other chemical tests also indicated that this area of the river was grossly polluted from discharge of sewage treatment plant effluents and urban runoff. (See Appendix B for pollution source information and Appendix D for chemical tests data.) While mortality was high in the upper reach of this area, mortality was almost 100 percent in the lower reach except for a few survivors in 20 percent elutriates.

(2) Planning Sub-area 4. Pollutant concentrations remained high in this area. D. magna mortality was almost 100 percent with only one survivor in 20 percent elutriate

(3) Planning Sub-area 3. Overall pollutant concentrations declined in this area. As a result, D. magna survival was almost 100 percent except for a slight decline at CRM 265.0.

(4) Planning Sub-area 2. D. magna survival was almost 100 percent in unfiltered samples and 6 percent filtered elutriates. The results indicate that there was extremely high mortality in filtered control and 20 percent filtered elutriate samples. The reasons for high mortality in filtered control and 20 percent filtered elutriates are unclear. This may have been due to experimental error.

Grain Size Distribution and Dispersion Tests

Grain size distribution analyses of soils are conducted for identification and classification purposes, for permeability and capillarity determinations, and for aid in designing and constructing filters, dams, and levees. Grain

TABLE 17. DAPHNIA MAGNA SURVIVAL AFTER 96 HOURS EXPOSURE TO TEST CONDITIONS

Planning Sub-area	Sampling Site(CRM)	Percent Survival					
		Centrifuged Samples			Filtered Samples		
		Control River Water	Elutriates 6%	20%	Control River Water	Elutriates 6%	20%
5	1(540.5)	0*	70*	90*	0*	90*	90*
		60	90	90	90	90	90
5	2(532.0)	30*	70*	20*	0*	80*	80*
		10	50	100	0	100	80
5	3(511.0)	30*	10*	40*	0*	10*	10*
		40	50	90	90	100	100
5	4(506.5)	0	0	0	0	0	10
5	5(504.5)	0	0	0	0	0	20
5	6(478.4)	0	0	0	0	50	10
5	7(456.5)	0	0	0	0	70	100
4	8(431.5)	0	0	0	0	0	10
3	9(341.0)	100	90	90	100	90	100
3	10(313.0)	100	90	100	100	100	100
3	11(265.0)	40	90	100	60	70	70
3	12(197.0)	100	100	90	100	100	100
2	13(125.0)	100	90	100	10**	100	30**

**See discussion.

Note: 1. For sampling sites 1, 2, and 3, D. magna mortality data was obtained with fed and unfed organisms.

2. Values with asterisk "*" indicate results for unfed organisms.

3. Values without asterisks indicate results for fed organisms.

size distribution analyses are generally necessary to determine the scouring and dispersion characteristics of the sediments.

Generally, clays have high adsorptive and cation exchange capacities and thus have high contaminant storage potential. Silts and clays retain heavy metals, pesticides and other compounds.

The grain size distribution analyses indicated that there was a wide variation in the sand, silt, and clay content in the bottom sediment samples. The grain size distribution curves for the 13 sampling sites is given in Appendix F. The results of the grain size distribution analyses are summarized in Table 18.

The dispersion test is a measure of nonsettleable solids in bottom sediments. Bottom sediments containing high proportions of clay and silt have more nonsettleable solids than sediments containing primarily sand. Also, bottom sediments immediately downstream from large sewage effluent discharge points contained high concentrations of nonsettleable solids. (See Appendix B for point source pollution data.) Results of the dispersion tests are given in Appendix D. Important results are summarized in Table 18.

TABLE 18. SUMMARY OF GRAIN SIZE DISTRIBUTION AND NONSETTLEABLE SOLIDS IN BOTTOM SEDIMENTS

Planning Sub-area	Sampling Site(CRM)	Sand %	Silt %	Clay %	Nonsettleable Solids mg/kg	Nonsettleable Solids Dry Wt.
5	1(540.5)	85	14.8	0.2	420	0.042
5	2(532.0)	66	32.0	1.0	830	0.083
5	3(511.0)	93	7.0	small	620	0.062
5	4(506.5)	48	51.6	0.4	1,470	0.147
5	5(504.5)	31	66.9	2.1	1,670	0.167
5	6(478.4)	32	67.0	1.0	8,560	0.856
5	7(456.5)	41	58.0	1.0	710	0.071
Average for Planning Sub-area 5		57	42.5	*	2,040	0.204
4	8(431.5)	70	28.2	1.8	2,650	0.265
3	9(341.0)	69	29.0	2.0	430	0.043
3	10(313.0)	50	33.8	16.2	710	0.071
3	11(265.5)	77	23.0	small	440	0.044
3	12(197.0)	30	68.2	1.8	1,620	0.162
Average for Planning Sub-area 3		57	38.5	*	800	0.080
2	13(125.0)	75	20.8	4.2	4,340	0.434

*Average could not be determined because one value could not be evaluated.

SUMMARY OF RESULTS

The principal findings of the Trinity River Bottom Sediment Reconnaissance Study are summarized below:

Static Bioassay

(1) The Trinity river is grossly polluted in Planning Sub-areas 5 and 4 mainly because of point and nonpoint source pollution from urban areas. High mortality of D. magna in river water from these areas showed that the river was unfit for habitation by these organisms and probably other forms of aquatic life. Ammonia nitrogen, in the presence of other pollutants, appeared to be the limiting factor in growth and survival of the test organism.

(2) Elutriation consistently improved water for habitation by D. magna. Filtration further improved the water for habitation. While ammonia nitrogen concentrations were not significantly lowered by elutriation, the elutriation procedures did result in the lowering of other pollutant concentrations to affect survival in elutriates. Ammonia nitrogen concentrations were not decreased with filtration. The higher survival of D. magna in filtered than in unfiltered samples therefore, was further indication that the effects of ammonia nitrogen are at least partially dependent upon the presence of other pollutants.

(3) Survival was greatest in Planning Sub-areas 3 and 2. In some sites, survival was slightly greater in the river water (control) than in the elutriates.

Water and Elutriates

(1) The pH of the river water ranged from 7.1 to 8.1.

(2) During the testing, the dissolved oxygen in the river water samples tested was greater than 4.2 mg/l and considerably higher (>7 mg/l) in Planning Sub-areas 3 and 2.

(3) Immediate oxygen demand test results indicated that anaerobic or low DO levels (<5 mg/l) will result in all areas except Planning Sub-area 2.

(4) The dissolved solids concentrations in river water ranged from 110 mg/l to 630 mg/l in Planning Sub-areas 5, 4, and 3 with most sites exceeding the 500 mg/l standard for drinking water. Lake Livingston discharge had a dissolved solids concentration of 180 mg/l. Elutriation procedures did not increase dissolved solids in river water and the concentrations were actually lowered in filtered elutriates from Planning Sub-areas 3 and 2.

(5) Ammonia nitrogen (AN) concentrations in river water ranged from 10 mg/l in Planning Sub-area 5 to 0.05 mg/l below Lake Livingston. The recommended EPA limit of 0.016 mg/l was exceeded at all sites. Most of the AN was in the dissolved state. Elutriation increased AN concentrations in the polluted Planning Sub-area 5 and either decreased or increased only slightly the AN concentration in Planning Sub-areas 4, 3, and 2. Organic nitrogen (ON) generally remained in particulate form. ON concentrations generally increased with elutriation. Filtration, however, significantly decreased ON concentrations.

(6) Total phosphorus (TP) concentrations ranged from 7.2. mg/l in Planning Sub-area 5 to 0.2 mg/l just above and below Lake Livingston. TP concentrations gradually decreased from Planning Sub-areas 5 to 2. Removal of phosphorus

from the river water depended upon the characteristics of the sediments. Filtered elutriates exhibited a decrease in TP concentrations.

(7) Total organic carbon concentrations in river water ranged from 42 mg/l to 16 mg/l with the highest values in Planning Sub-area 5. Most of the organic carbon in the river water was in soluble form. Unfiltered elutriates exhibited high organic carbon concentrations especially in Planning Sub-area 5. In filtered elutriates, organic carbon concentrations were only slightly higher than those in filtered river water.

(8) Heavy metals concentrations were highest in Planning Sub-area 5. Manganese, lead, and chromium concentrations exceeded the recommended EPA limits at most sites. Cadmium concentrations fluctuated around the limit at most sites. Arsenic, copper, mercury, and zinc concentrations were well below the recommended limits at all sites. Elutriation generally increased manganese, arsenic, and zinc concentrations. Elutriation results with the other heavy metals varied widely depending on the quality of the bottom sediments. The heavy metals were in particulate form and were removed significantly by filtration.

(9) Pesticide concentrations were found to be highest in Planning Sub-area 3. No chlordane was detected in any of the water samples tested. Elutriation gave no consistent results, perhaps because the release or uptake of pesticides depended upon the quality of the bottom sediments, the solubility of the pesticides, and other interfering compounds present. No polychlorinated biphenyls were detected in any of the water sampled.

Bottom Sediments

(1) All bottom sediments were anaerobic except those from Planning Sub-area 2. The Eh of bottom sediments from Planning Sub-areas 5, 4, and 3 ranged between -360 and -15 mv.

(2) The volatile solids concentrations in bottom sediments from the lower reach of Planning Sub-area 5 exceeded the EPA limit of 80,000 mg/kg.

(3) The bottom sediments contained high concentrations of ammonia and organic nitrogen. The concentrations of nitrogen gradually decreased from Planning Sub-areas 5 to 2. Most of the ammonia nitrogen was in a dissolved state and was released into the elutriates. At most of the sites in Planning Sub-area 5 the total Kjeldahl nitrogen concentration exceeded the recommended EPA limit of 1000 mg/kg.

(4) Total phosphorus concentrations in bottom sediments were very high in Planning Sub-area 5. For sites 2, 4, 5, and 6, TP values were 1400, 3850 2170, and 5660 mg/kg. Phosphorus concentrations decreased from Planning Sub-areas 5 to 2.

(5) The recommended EPA limit of 50,000 mg/kg for chemical oxygen demand (COD) was exceeded in the lower reach of Planning Sub-area 5. COD in bottom sediments decreased from Planning Sub-areas 5 to 2. Total organic carbon in bottom sediments also decreased from Planning Sub-areas 5 to 2.

(6) Oil and grease concentrations ranged from 8340 mg/kg to 380 mg/kg. As with other pollutants, the lower reach of Planning Sub-area 5 exhibited the highest concentrations of oil and grease.

(7) Most of the heavy metals concentrations in bottom sediments from the lower reach of Planning Sub-area 5 exceeded the recommended EPA limits for Region VI. Cadmium and lead concentrations were above limits in most of the planning sub-areas. The mercury concentration of 2.2 mg/kg at Site 7 was the only concentration above the EPA recommended limit of 1.0 mg/kg. This sampling site was only a few miles downstream from the East Fork of the Trinity River.

(8) The bottom sediments were constantly scoured under high flow conditions and deposited at the lower reaches of the river and into Lake Livingston. Site 12 was sampled approximately one week after heavy rains and the river at the time of sampling was under flood conditions. The bottom sediments from Site 12 contained higher concentrations of phosphorus, nitrogen, COD, and other contaminants than those at the sites upstream from Site 12 in Planning Sub-area 3, even though there is no significant source of pollution in the reach upstream from Site 12.

(9) Halogenated hydrocarbons were found in the highest concentrations in Planning Sub-areas 5 and 4. Chlordane was found only in the bottom sediments from Planning Sub-area 5. No polychlorinated biphenyls (PCBs) were found in any of the bottom sediments tested.

RECOMMENDATIONS

During the Trinity River Bottom Sediment Reconnaissance Study water and sediment quality at 13 sites on the Trinity River was established. Insufficient data exists to make specific recommendations for the entire river. Considering the scope of the Trinity River Project, it is recommended that the U.S. Army Corps of Engineers consider building upon the present study a continuing monitoring program consisting of the following steps:

1. Analysis of Soil Samples from River Banks

The upper reaches of the Trinity River are grossly polluted. The river bottom sediments have COD, nitrogen, and many heavy metals concentrations considerably above the EPA recommended limits for Region VI. The Corps should consider determining the quality of soil samples that were collected from each bank and frozen during this study. The study should include determination of the quality of the soil samples and elutriation studies with distilled water to determine the mobility of the constituents. Implementation of the above study would be a prudent course of action for the Corps to take in the event that off-channel alignment were necessary.

2. Trinity Bay Bottom Sediment Analysis

A study similar to the Trinity River Bottom Sediment Reconnaissance Study should be conducted on the Trinity Bay to determine the water and sediment quality and the mobility of contaminants during dredging operations. The study would provide data on contaminants that have accumulated in the bottom sediments that are under less transient conditions. Tests conducted in a saline environment to determine the quality and leachability of contaminants would probably yield

quite different results from those conducted in the upper reaches of the river investigated during this program.

3. Treatability Studies with Bottom Sediments

(a) Biological Studies. In the upper reaches of the Trinity River, the bottom sediments have high organic contents and are anaerobic. A study should be conducted to determine the biodegradability and biostabilization of the bottom sediments. Respiration studies using a Warburg respirometer or similar apparatus would indicate the oxygen requirement. Kinetic coefficients using a respirometer and batch reactor would provide information which could be used to stabilize the dredge material.

(b) Dewatering Studies. Studies should be conducted to determine the factors that control the thickening and dewatering of the bottom sediments. These studies would include thickening, coagulation and sedimentation experiments. Classical experiments using sedimentation columns and Büchner funnel tests would provide the design parameters for sedimentation, chemical feed, thickening, and filtration processes.

4. In-Stream Aeration Studies

In order to improve the water and sediment quality of the Trinity River, paper studies should be conducted to investigate the various methods of in-stream aeration for the Trinity River. The study should include means of natural and artificial aeration systems. Consideration should be given to increasing the reaeration in the river by special designs of locks and dams and other hydraulic structures. Aeration requirements in the navigation channel should also be given consideration.

5. Dredged Material Disposal Sites and Potential Use of Dredged Material

Paper studies should be conducted to identify dredged material disposal sites with an effort to use the material for beneficial purposes. Studies should include disposal into gravel pits and strip-mined areas to improve the land for agriculture and other uses, construction of large elevators for recreational uses, and development of artificial marshes.

A modest level of experimental research should also be conducted to determine the uptake of heavy metals and pesticides into plants and aquatic animals. Studies should be conducted to determine the use of dredged material in construction work. The possibility of constructing synthetic aggregates from dredged material should also be investigated.

6. Trinity River Scale Model

Public participation in any engineering project is a two-way communication process which involves promoting full public understanding of the project. To communicate effectively, it is recommended that the Corps initiate construction of models or replicas of several sections of the river. The replicas should be constructed to a suitable scale (1 ft to a mile) for river sections of 10 to 15 miles in length. Two replicas should be considered: one representing the existing condition of the river giving details or bank erosion, fallen trees, accumulated debris in the channel, etc. and a second replica indicating channel alignment, locks and dams, bank stabilization, etc. of the same sections of the river. A side by side comparison of the two sections of the river would clearly indicate the objectives of the Trinity River Project. These models should be made available for public display whenever suitable opportunities arise.

7. Water Quality Characterization in the Trinity River Basin

The Trinity River receives wastes directly from treatment plants. Also, many tributaries empty large volumes of municipal and industrial wastes into the Trinity River. In order to meet the Corps' objectives of the Trinity River Project, "recreation and fish and wildlife conservation," it is necessary that the water quality of major tributaries and pollution entering the Trinity River through these tributaries be characterized. Water quality characterization based upon the criteria for (1) public water supply, (2) recreation and aesthetics, (3) fish and other aquatic life, (4) industrial, and (5) agricultural (irrigation) water supply should be conducted for many reaches of the tributaries and the Trinity River. The program can be conducted in two phases: (1) characterization of existing water quality based upon available water quality data, and (2) projected future water quality in this river based upon projected population and industrial growth and regulatory constraints.

REFERENCES

Duchart, P., Calvert, S. E., and Price, W. B., "Distribution of Trace Metals in the Pore Water of Shallow Water Marine Sediments," Limnology and Oceanography, Vol. 18, 1973.

EPA 1976. "Quality Criteria for Water" Prepublication copy. EPA report #EPA-440/9-76-023.

Johnson, E. E., and Johnson, J. C., Identifying and Prioritizing Locations for the Removal of In-Place Pollutants. Washington, D.C.: Office of Water Planning Standards, U.S. Environment Protection Agency.

Lee, G. F., "Role of Hydrous Metal Oxides in the Transport of Heavy Metals in the Environment," Proceedings, Symposium on Heavy Metals in the Environment, Vanderbilt University, Nashville, Tennessee, 1973.

"Navigable Waters Discharge of Dredged or Fill Material," Federal Register, Vol. 40, No. 173, 5 September 1975.

"Permits for Activities in Navigable Waters or Ocean," Federal Register, Vol. 40, No. 144, 25 July 1975.

"Primary Drinking Water Proposed Interim Standards," Federal Register, Vol. No. 51, 14 March 1975.

Proposed Guidelines for Determining Acceptability of Dredged Sediments Disposal in EPA - Region VI, 1973.

"Report of the Committee on Water Quality Criteria," Permissible Surface Water Criteria, U.S. Department of the Interior, 1968.

"Selective Analytical Partitioning of Sediments to Evaluate Potential Mobility of Chemical Constituents During Dredging and Disposal Operations," Environmental Effects Laboratory, US Army Engineers Waterway Experiment Station, Vicksburg, Mississippi, Technical Report D-76-7, December 1976.

"Trinity River Bottom Sediment Reconnaissance Study Phase I - Plan of Work," prepared for the Fort Worth District Corps of Engineers by the University of Texas at Arlington, Contact No. DACW 63-76-C-0140, November 1976.

References from "Trinity River Bottom Sediment Reconnaissance Study Phase I - Plan of Work"

"Approved EPA Analytical Methods for Dredged or Fill Material," Appendix A, EPA, (undated).

Bellar, T. A. and Lichtenberg, J. J., "Method for the Determination of Polychlorinated Biphenyls in Water and Sediment," U.S. Environmental Protection Agency, National Environmental Research Center, Analytical Quality Control Laboratory, Cincinnati, Ohio 45268, 1973.

"Chemistry Laboratory Manual, Bottom Sediments," compiled by Great Lake Region, Committee on Analytical Method, 1969.

Ecological Evaluation of Proposed Discharge of Dredged or Fill Material into Navigable Waters, Interim Guidance for Implementation of Section 404(b)(1) of PL 92-500. Environmental Effects Laboratory, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi, May, 1976.

Goerlitz, D. F. and Law, L. M. "Note on Removal of Sulfur Interferences from Sediment Extracts for Pesticide Analysis," Bulletin of Environmental Contamination and Toxicology, 6, 9 (1971).

Leoni, V., "The Separation of Fifty Pesticides and Related Compounds and Polychlorinated Biphenyls into Four Groups by Silica Gel Micro-column Chromatography," Journal of Chromatography, 62, 63 (1971).

"Manual of Methods for Chemical Analysis of Water and Wastes," EPA-625-/6-74-003, 1974.

McClure, V. E., "Precisely Deactivated Adsorbents Applied to the Separation of Chlorinated Hydrocarbons," Journal of Chromatography, 70, 168 (1972).

"Methods for Acute Toxicity Tests with Fish, Macroinvertebrates, and Amphibians," EPA Corvallis, Oregon EPA-660/3-75-0009, April 1975.

"Methods for Organochlorine Pesticides in Industrial Effluents," U.S. Environmental Protection Agency, National Environmental Research Center, Analytical Quality Control Laboratory, Cincinnati, Ohio 45268, 1973.

Mills, P. A., "Variation of Florisil Activity: Sample Method for Measuring Adsorbent Capacity and Its Use in Standardizing Florisil Columns," Journal of the Association of Official Analytical Chemists, 51, 29 (1968).

"Pesticide Analytical Manual," U.S. Dept. of Health, Education, and Welfare, Food and Drug Administration, Washington, D.C.

Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1975.

Status Report of Environmental Evaluation, Trinity River Project, Appendix A, FWD, Corps of Engineers, 1975.

Steere, N. V., Editor, "Handbook of Laboratory Safety," Chemical Rubber Company, 18901 Cranwood Parkway, Cleveland, Ohio 44128, 1971, pp. 250-254.

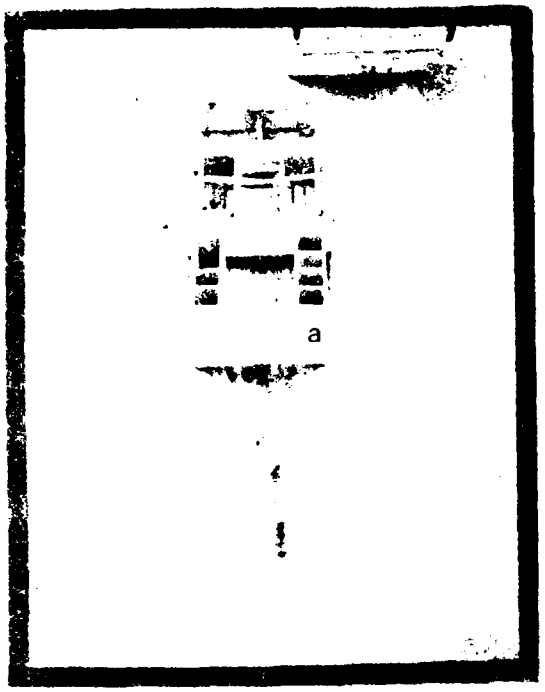
Webb, R. G. and McCall, A. C., "Quantitative PCB Standards for Electron Capture Gas Chromatography," Presented at the 164th National ACS Meeting, New York, August 29, 1972. (Submitted to the Journal of Chromatographic Science for publication).

APPENDIX A

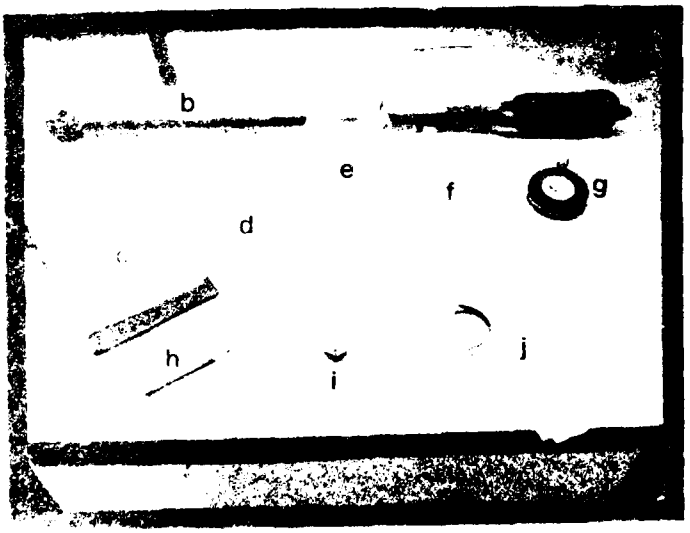
FIELD SAMPLING, ELUTRIATION, AND SEDIMENT ANALYSIS EQUIPMENT

APPENDIX A

FIELD SAMPLING, ELUTRIATION, AND SEDIMENT ANALYSIS EQUIPMENT



a. Sampling boat, aluminum, 14 foot; powered by 7 1/2 HP outboard motor



b. Earth Auger, manually operated 3 inch diameter core

c. Notebook

d. Lid liner, Teflon, 20 mil

e. Sample storage jar, one gallon, wide mouth, glass, screw top

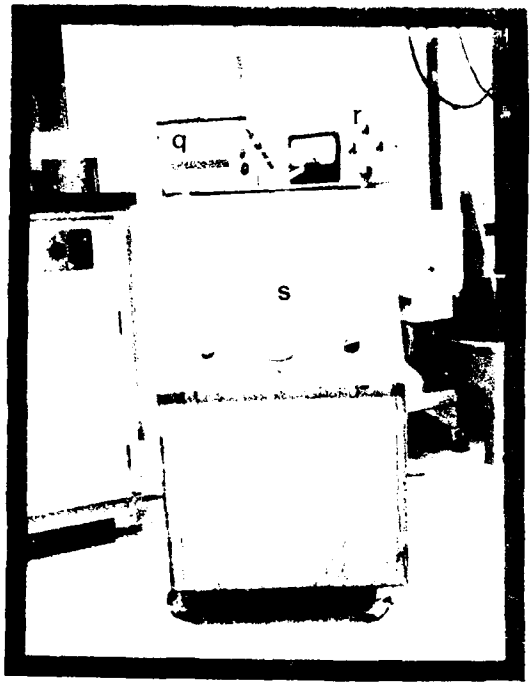
f. Sample storage jar lid

g. Measuring tape, 50 feet

h. Marker, red

i. Thermometer

j. Plastic sample bags and ties

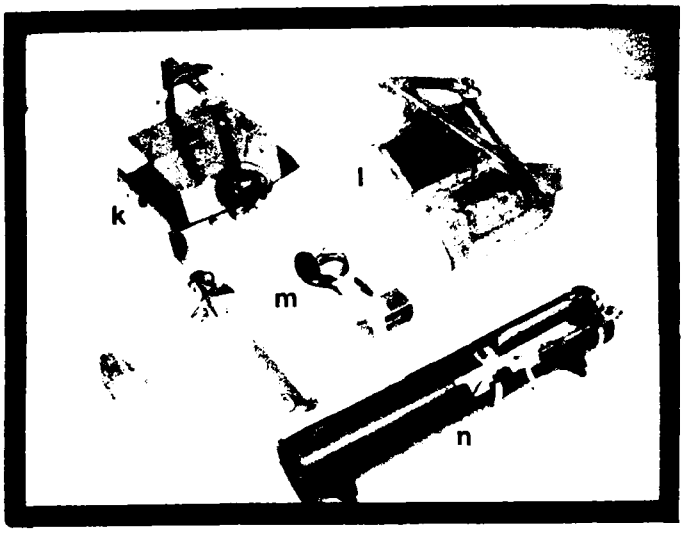


q. Chemtrix. Eh and pH meter

r. Yellow spring, Model 54, DO meter

s. International Model CS, centrifuge

t. Radio set, An/PRC. Two sets were used to keep contact between crew in boat and on shore

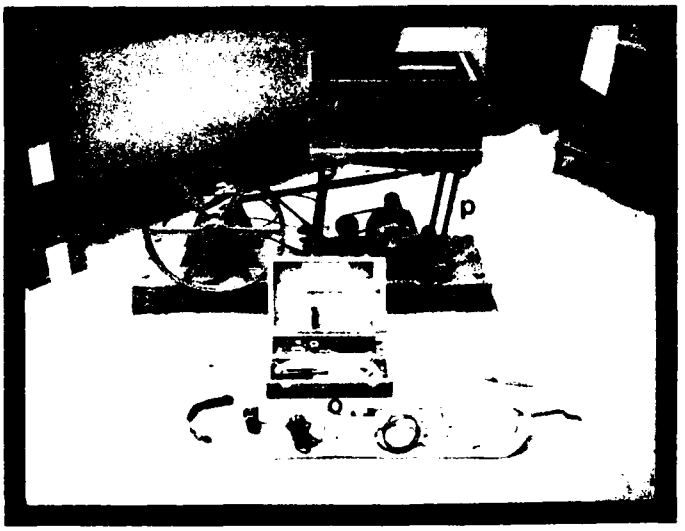


k. Standard Wildco-Eckman dredge

l. Ponar grab dredge

m. Teledyne-Gurley Price current meter

n. Alpha style - vertical PVC bottle with semi-rigid ends



o. Pigmy Price current meter

p. Shaker, Dayton Electric Manufacturing Company

Description of Sampling and Sample Preparation Equipment

The following equipment or equivalent was used during field samplings, elutriation and sediment analysis:

Standard Wildco-Eckman Dredge

Chamber Dimensions 9" x 9"

Empty weight, 15 lbs

Page 9A Wildco Catalog 74A

Ponar Grab Dredge

Chamber Dimensions 9" x 9"

Empty weight, 15 lbs

Page 11 Wildco Catalog 74A

Alpha Style - Vertical PVC Bottle with Semi-Rigid Ends

Volume 4.3 l

OD 4 1/2"

End seal, Neoprene

Empty weight, 10 lbs

Sample Storage Bottles

Wide mouth glass jars, one gallon capacity with Teflon liner, screw-top lid

Possible source Cincinnati Container Corporation, Cincinnati, Ohio

Teflon Sheet

20 mill thick

Source: Cadillac plastic, Cincinnati, Ohio

Boat

Aluminum fishing boat 12 to 16 feet; light weight, 7 1/2 hp motor, removable; speed 10 mph

pH Eh Measurement

Direct reading, portable, battery operated, expanded scale unit for field measurement. (Sargent-Welch, Model PBX, page 497, Catalog 124)

DO Meter

Oxygen, polaragraphic cell, Portable YSI Model 54

Current Meter

1. Teledyne-Gurley Price, for deep water

2. Pigmy Price, for shallow water

Velocity determination from rating tables for each instrument. Teledyne-Gurley meter with a magnetic on-off switch activated at every ten revolutions of the current meter wheel. The Pigmy current meter with direct flow on-off switch for every ten revolutions.

Photographic Equipment

1. 35 mm slide and photograph camera

2. 8 mm movie camera

Membrane Filter Assembly

1. 0.45 micron membrane filter

2. Suction apparatus

3. Container and holder

Centrifuge

Large, International Equipment Co.; Model CS

1. Timer, brake, adjustable speed

2. Top speed = 3200 RPM

Shaker

1. 1/3 hp electric motor, Dayton Electric Manufacturing Co., 1725 rpm. Type KS

18" x 10" x 7 1/2" box, adjustable seat, 120 excursions per minute

APPENDIX B

SAMPLING SITE LOCATION, PHOTOGRAPHS, AND DESCRIPTIONS

APPENDIX B

SAMPLING SITE LOCATION, PHOTOGRAPHS, AND DESCRIPTIONS

Sampling Site No. 1 Planning Sub-area 5

Sampled on Friday, November 5, 1976, 9:55 A.M.

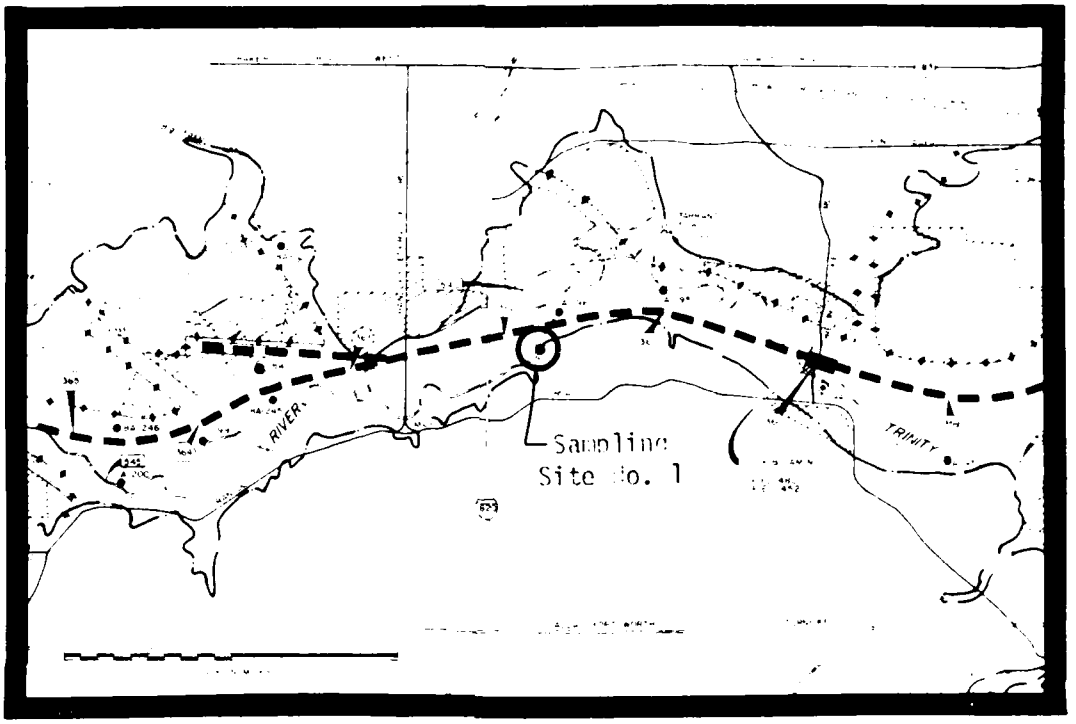


FIGURE B-1. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 1 (Corps River Mile 540.5; Channel Mile 361.8)

FIGURE B-2. SAMPLING SITE NO. 1. ACCESS PHOTOGRAPH

Description of Sampling Site No. 1

Access: The boat was launched from the right bank, downstream of the Handley-Ederville Road Bridge. The site was located 0.5 mile downstream of the I-820 Bridge.

Physical Description: The river was narrow (< 50 feet), shallow (< 10 feet), and sluggish. Branches and stumps obstructed the river's flow and many shallows and ruffles were present. The banks were rocky with extensive silt along the edges. No scouring was evident. Vegetation consisting of trees, shrubs, and grasses was dense. The only evidences of aquatic fauna were a few water snakes seen. The day was bright, calm, and clear with no clouds. No precipation was recorded during the preceding week but there were heavy rains the week before that.

Temperature:	15°C air
	20°C water
	20.5°C bottom sediments
Midstream velocity:	0.42 fps

Appearance of Water in Bulk: The water was muddy-green with considerable suspended matter and covered with foam. Visibility was only 10-12 inches. A strong putrid, fecal odor indicative of grossly polluted water was present.

Soil Sampling Site Location: On both banks, the soil sampes were taken approximately 300 yards downstream of the I-820 Bridge - 75 feet inland on the right and 150 feet inland on the left.

Sources of Pollution:

Point Sources: Five point sources of pollution were identified along the 30 mile reach upstream from Site No. 1. Of these, only the Riverside STP (effluent 32.3 MGD) was considered a major source. Other sources were a power plant, a petrochemical plant, and two small STPs. The total point source effluent was 33.8 MGD.

Land Use Activity Along the Reach:

35%	pasture and range
7%	forest
35%	crop land
15%	urban
8%	other

Storm Runoff: Little and Big Fossil Creeks and other small creeks drained the urbanized areas of the city of Fort Worth into the Trinity River.

Sampling Site No. 2 Planning Sub-area 5

Sampled on Friday, November 5, 1976 2:45 P.M.

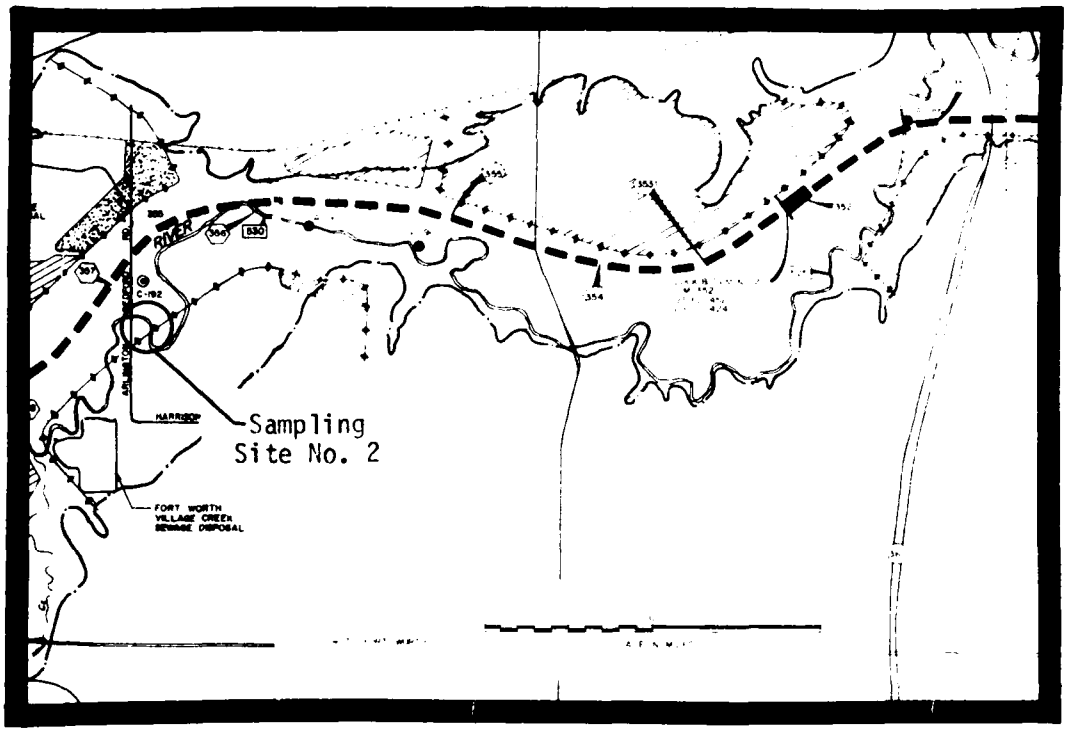


FIGURE B-3. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 2
(Corps River Mile 532.0; Channel Mile 357.0)

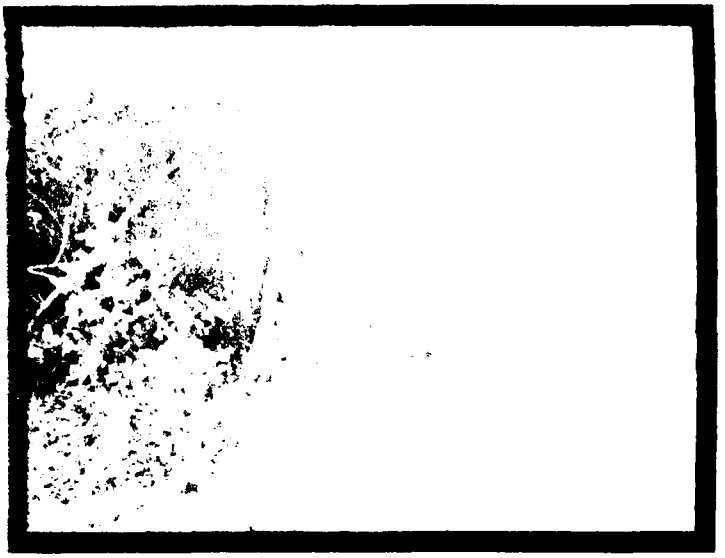


FIGURE B-4. SAMPLING SITE NO. 2. ACCESS PHOTOGRAPH. VIEW OF BOAT LAUNCHING FROM TOP OF BANK. A SAFETY LINE WAS USED TO LOWER THE BOAT AND EQUIPMENT.

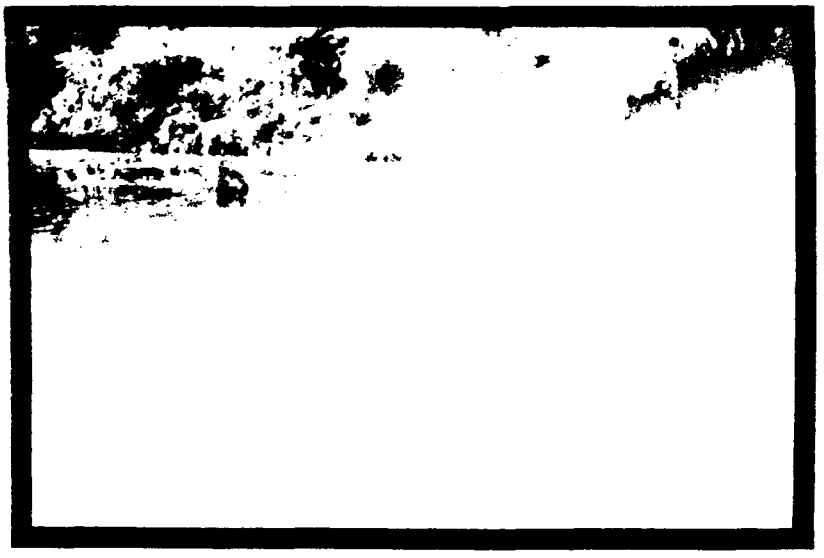


FIGURE B-5. SAMPLING SITE NO. 2. VIEW OF RIVER. FLOATING FOAM VISIBLE

Description of Sampling Site No. 2

Access: The boat was launched from the right bank, upstream of the Arlington-Bedford Bridge. The site was located 0.25 mile downstream of the Arlington-Bedford Bridge.

Physical Description: The river was narrow (~50 feet) deep (~25 feet), and sluggish. Numerous tree trunks and branches obstructed the river's flow. The banks were slippery with mud and some scum. There was evidence of siltation on the right bank. No scouring was evident. The vegetation, consisting of weeds, trees, and shrubs, grew to the water's edge. There was no evidence of aquatic fauna. The day was bright, calm, and clear with no clouds. No precipitation was recorded during the preceding week.

Temperature:	15°C	air
	20°C	water
	20.5°C	bottom sediment
Midstream velocity:	1.09	fps

Appearance of Water in Bulk: The water had a muddy-gray, sewage-like color. The water contained excessive amounts of suspended matter and had patches of brown foam floating on it. Visibility was only about 4 inches. A strong putrid odor was present along with the odor of oil and grease.

Soil Sampling Site Location: On both banks, the soil samples were taken approximately 100 yards downstream of the Arlington-Bedford Bridge - 60 feet inland on the right and 20 feet inland on the left.

Sources of Pollution:

Point Sources: Nine point sources were identified along the 10 mile reach upstream from site No. 2. Of these, only the Village Creek STP (effluent 45 MGD) was considered a major source. Other sources were seven small STPs and a manufacturing plant. The total point source pollution was 45.6 MGD. In addition, point source pollution from the reach above site No. 1 was close enough to have some effects.

Land Use Activity Along the Reach:

35%	pasture and range
7%	forest
35%	crop land
15%	urban
8%	other

Storm Runoff: The storm runoff from Village and Walker Creeks may provide a major nonpoint source of pollution due to urban density in the vicinity of the reach.

Sampling Site No. 3 Planning Sub-area 5

Sampled on Monday, November 8, 1976, 9:45 A.M.

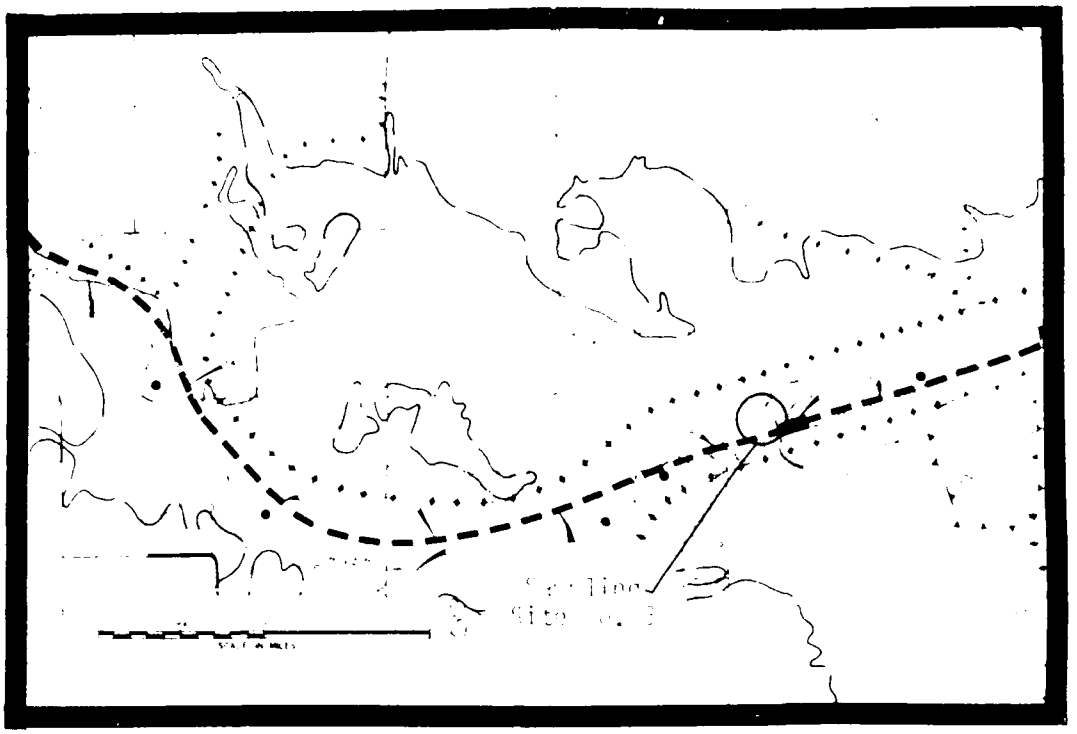


FIGURE B-6. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 3 (Corps River Mile 511.0; Channel Mile 343.5)

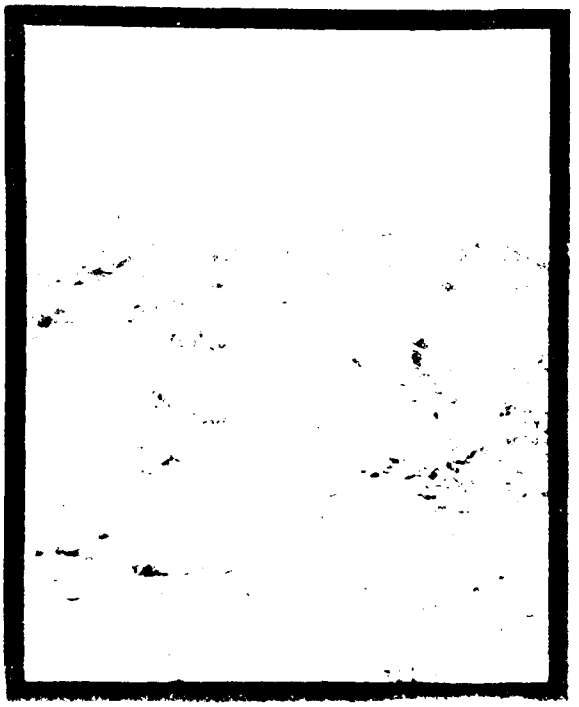


FIGURE B-7.

SAMPLING SITE NO. 3. ACCESS PHOTOGRAPH. RIVER BANK AT THE LAUNCHING SITE. SAFETY LINE WAS INSTALLED AND STEPS WERE MADE IN THE BANK

FIGURE B-8. SAMPLING SITE NO. 3. VIEW OF THE RIVER

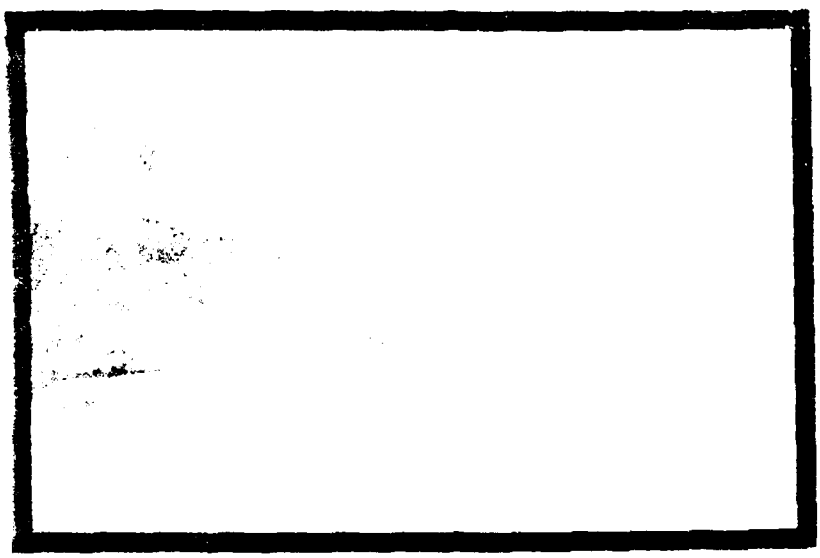


FIGURE B-9. SAMPLING SITE NO. 3. DEBRIS ALONG THE RIVER BANK

Description of Sampling Site No. 3

Access: The boat was launched from the left bank, downstream of the Meyers Road Bridge. The site was located 0.5 mile downstream of the Meyers Road Bridge.

Physical Description: The river was narrow (<50 feet), shallow (<10 feet), and sluggish. Considerable debris including car bodies, branches and tree trunks obstructed river flow. There was evidence of some siltation along the banks. No scouring was evident. Plant life was abundant down to water's edge. Insects, larvae and schools of minnows were seen in the water. The day was bright, calm, and clear with no clouds. Some fog was present over the water. No precipitation was recorded during the preceding week.

Temperature:	11°C	air
	19.5°C	water
	17.5°C	bottom sediment
Midstream velocity:	0.70	fps

Appearance of Water in Bulk: The water was turbid green in color with patches of white foam floating on the surface. Visibility was only about 2 inches. No obvious odor was noticed near the river.

Soil Sampling Site Location: On both banks, the soil samples were taken approximately 150 yards downstream of the Meyers Road Bridge - 40 feet inland on the right and 20 feet inland on the left.

Sources of Pollution:

Point Sources: Only two point sources were identified along the 24 mile reach upstream from Site No. 3. The Arlington STP (effluent 6.5 MGD) was previously the major source but has since been abandoned leaving only one small STP (effluent 0.5 MGD) as a point source of pollution. Signifcant pollution may be carried from the sites upstream with the Village Creek STP a major contributor.

Land Use Activity Along the Reach:

28%	pasture and range
6%	forest
40%	crop land
16%	urban
10%	other

Storm Runoff: Storm runoff may be a significant source of nonpoint pollution because this reach of the river receives runoff from the relatively densely populated midcities area of Arlington, Irving, and Grand Prairie.

Sampling Site No. 4 Planning Sub-area 5

Sampled on Friday, December 3, 1976, 9:00 A.M.

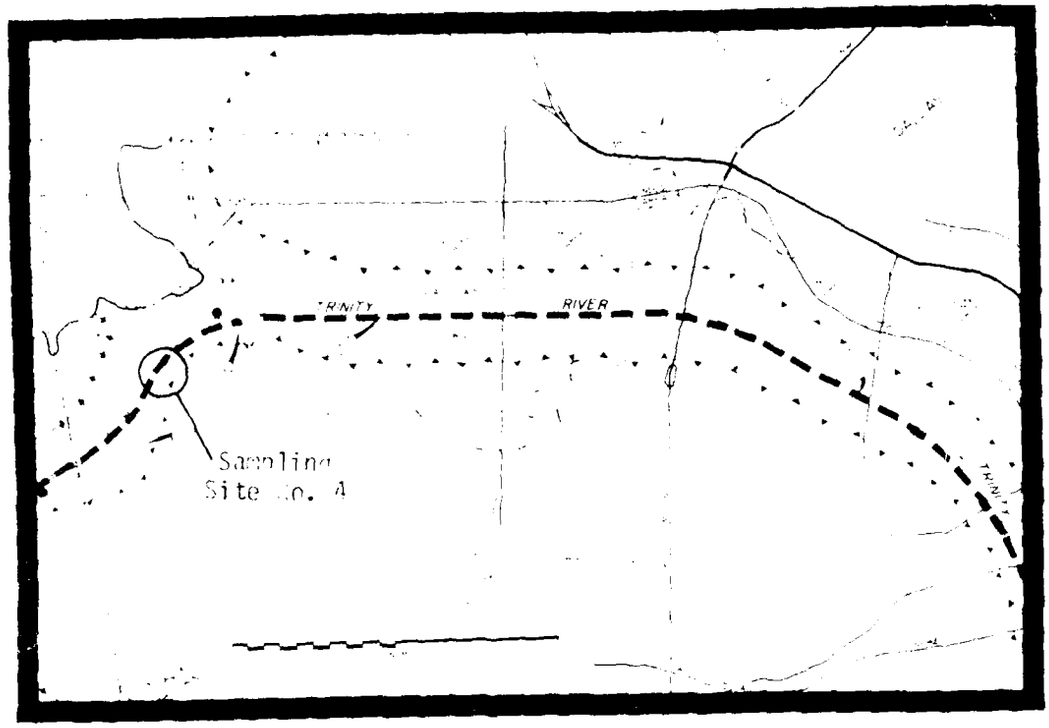


FIGURE B-10. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 4 (Corps River Mile 506.5; Channel Mile 339.8)

FIGURE B-11. SAMPLING SITE NO. 4. ACCESS PHOTOGRAPH. LAUNCHING THE BOAT AT THE MOUTH OF A DRAINAGE CHANNEL

FIGURE B-12. SAMPLING SITE NO. 4. A 24-INCH PIPE WHICH APPEARED TO DISCHARGE INTO THE RIVER

FIGURE B-13. SAMPLING SITE NO. 4. AN OLD COLLAPSED BRIDGE PIER AND DEBRIS

Description of Sampling Site No. 4

Access: The boat was launched from the right bank, 0.25 mile downstream of the Loop 12 Bridge from a point where a drainage ditch enters the Trinity River from a levee south of the river. The site was located 0.75 mile downstream of the Loop 12 Bridge.

Physical Description: The river was narrow (<50 feet), shallow (<10 feet), and swift except for isolated sluggish pockets. Branches, tree strunks and debris occasionally obstructed the river flow and rapids and shallows were present. The river bottom appeared rocky. No scouring was evident. There was no vegetation along the banks or in the river, except for brown algae in the shallows. There was no evidence of aquatic fauna. The day was bright, calm, and clear with no clouds. No precipitation had been recorded during the preceding four weeks.

Temperature	18°C	air
	15.5°C	water
	15.5°C	bottom sediment
Midstream velocity:	1.27	fps

Appearance of Water in Bulk: The water was gray and very turbid with some floc. Gas bubbles and black rise were seen when the bottom sediments were disturbed. Visibility was minimal. The odor of hydrogen sulfide gas and a strong fecal odor were present.

Soil Sampling Site Location: On both banks, the soil samples were taken approximately 0.75 mile downstream of the Loop 12 Bridge - 150 feet inland on right and 50 feet inland on left.

Sources of Pollution:

Point Sources: Eight point sources of pollution were identified along the 5 mile reach upstream from Site No. 4. Of these, only the TRA Central STP (effluent 30 MGD) was considered a major source. Other sources were 3 mobile home STPs and 4 other small STPs. The total point source effluent was 30.6 MGD. Significant pollution from the upper reaches was carried over into this site.

Land Use Activity Along the Reach:

28%	pasture and range
6%	forest
40%	crop land
16%	urban
10%	other

Storm Runoff: Significant nonpoint source pollution is fed into the river as urban runoff by Little Bear, Big Bear, and Estelle Creeks.

Sampling Site No. 5 Planning Sub-area 5

Sampled on Friday, December 3, 1976, 11:45 A.M.

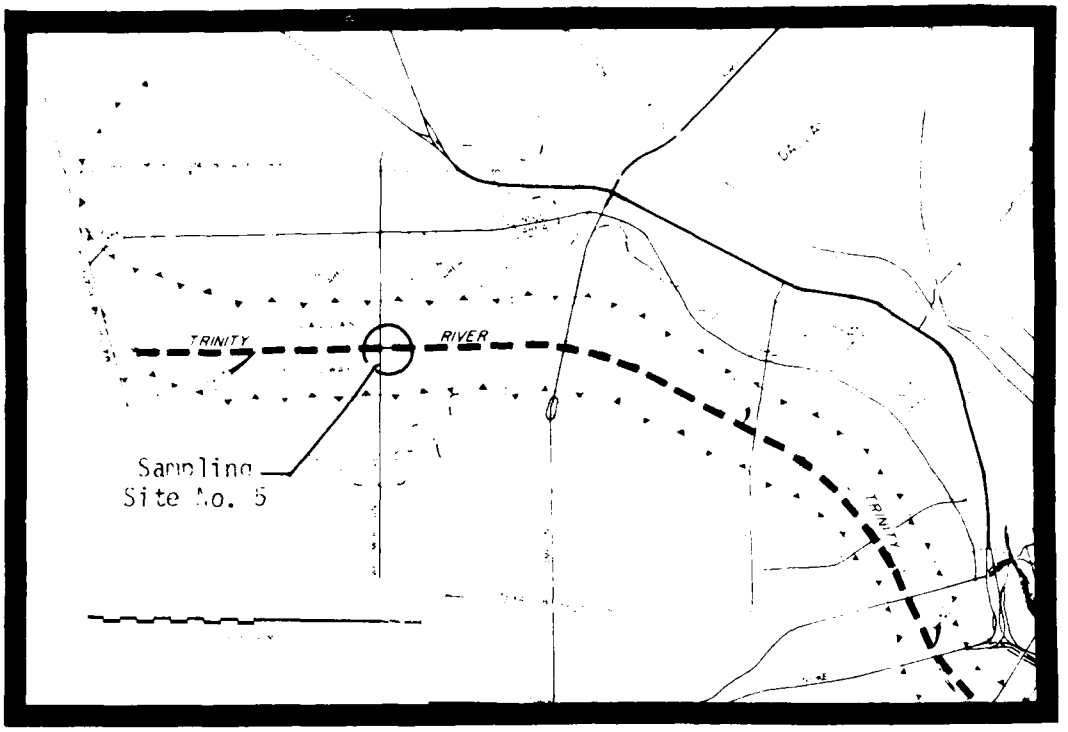


FIGURE B-14. CHANNEL ALIGHMENT AND LANDMARK MAP OF SAMPLING SITE NO. 5 (Corps River Mile 504.5; Channel Mile 337.5)

FIGURE B-15. SAMPLING SITE NO. 5. WESTMORELAND AVE BRIDGE

FIGURE B-16. SAMPLING SITE NO. 5. ACCESS PHOTOGRAPH. LAUNCHING THE BOAT

FIGURE B-17. SAMPLING SITE NO. 5. BLACK RISE AND GAS BUBBLES IN THE RIVER

Description of Sampling Site No. 5

Access: The boat was launched from the right bank downstream of the Westmoreland Avenue Birdge. The site was located 0.2 mile upstream of the Westmoreland Avenue Bridge.

Physical Description: The river was moderately wide (>50 feet, <200 feet), (<10 feet) and sluggish. Trees and branches obstructed flow. There was little sedimentation and the bottom was rocky with considerable sand and gravel. There were fine clay and silt on the right bank and sand on the left. No vegetation was observed on banks or in water. Bloodworms, insect larvae, and minnows were observed in the water. The day was bright, calm, and clear with no clouds. No precipitation was recorded during the preceding four weeks.

Temperature:	21°C	air
	15°C	water
	15°C	bottom sediment
Midstream velocity:	0.7	fps

Appearance of Water in Bulk: The water was turbid and had a dark brown color. Gas bubbles and floc rose when the bottom sediment was disturbed. No apparent odor was present except for the putrid smell of the bottom sediment.

Soil Sampling Site Location: On both banks, the soil samples were taken approximately 352 yards upstream of the Westmoreland Avenue Bridge - 150 feet inland on the right and 150 feet inland on the left.

Sources of Pollution:

Point Sources: Since Site No. 5 is located approximately 2.0 miles downstream from Site No. 4, all point sources for Site No. 4 are potentially significant at Site No. 5. In addition, the Elm Fork of the Trinity River joins the river between the two sites. This tributary adds point source pollution from 5 STPs 1 WTP located on the Elm Fork. The total effluent from Elm Fork point sources was 17.7 MGD. Combining the point sources from Site No. 4 and the Elm Fork gave approximately 48 MGD.

Land Use Activity Along the Reach:

28%	pasture and range
7%	forest
43%	crop land
14%	urban
8%	other

Storm Runoff: The Elm Fork of the Trinity River receives large amounts of runoff from farm and pasture land.

Sampling Site No. 6 Planning Sub-area 5

Sampled on Monday, December 27, 1976, 12:30 P.M.

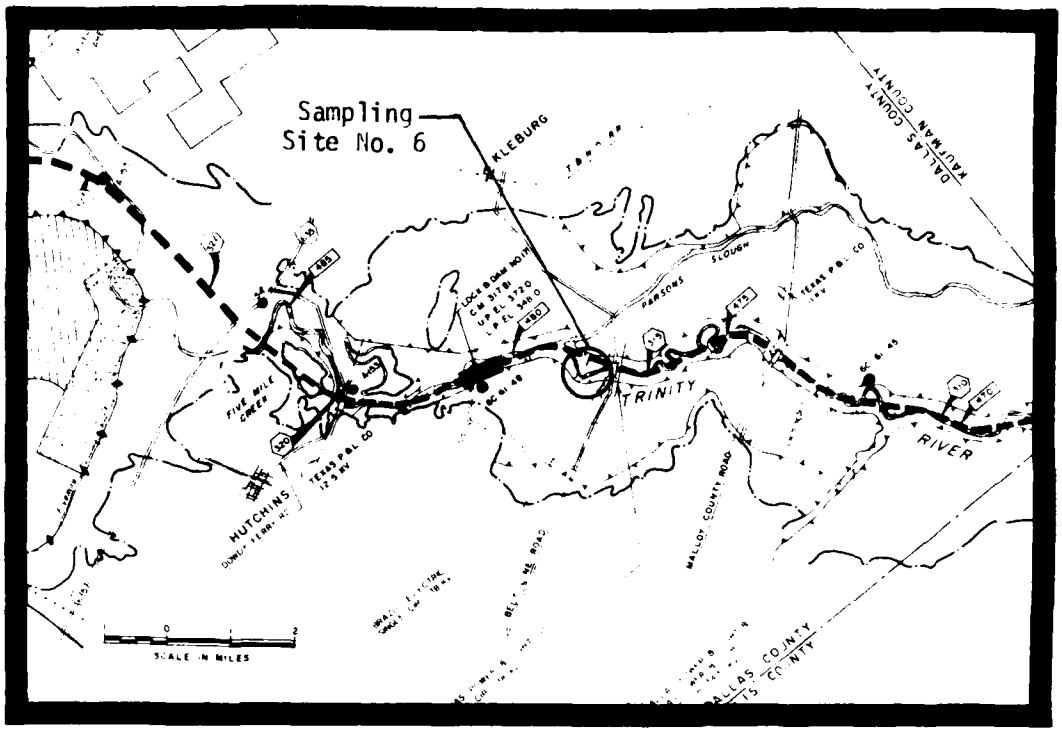


FIGURE B-18. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 6 (Corps River Mile 478.4; Channel Mile 315.9)

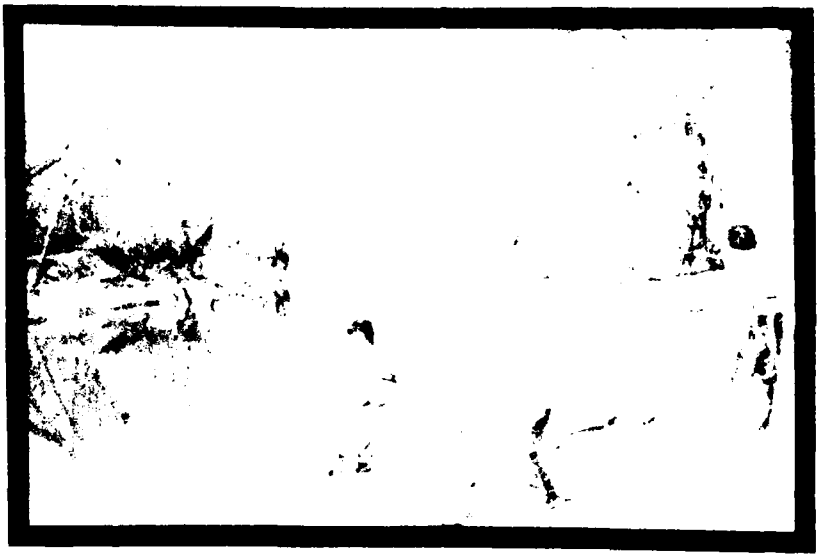


FIGURE B-19. SAMPLING SITE NO. 6. ACCESS PHOTOGRAPH

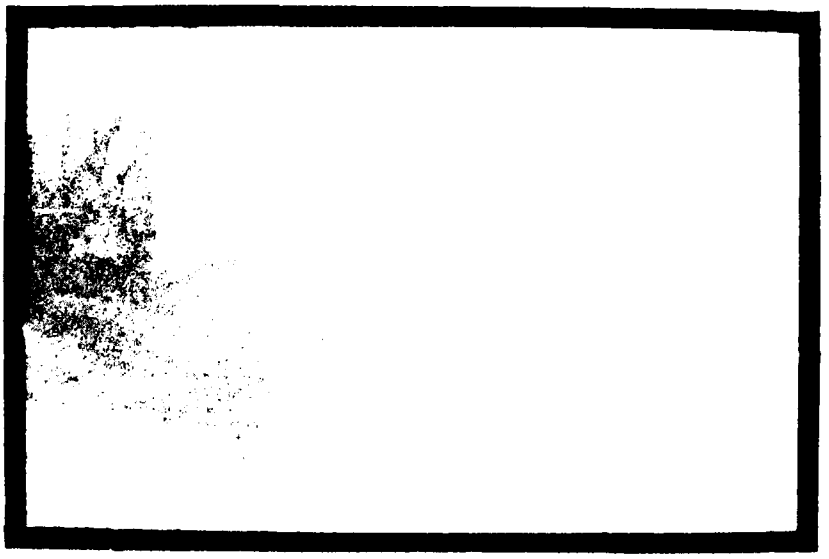


FIGURE B-20. SAMPLING SITE NO. 6. VIEW OF THE RIVER

Description of Sampling Site No. 6

Access: The boat was launched from the left bank, downstream of the Belt Line Road Bridge. The site was located 600 feet upstream of the Belt Line Road Bridge.

Physical Description: The river was moderately wide (50 feet, <200 feet), moderately deep (~10 feet, 25 feet), and sluggish. Many branches were present but none could be considered a major obstruction. The banks were muddy, and some sedimentation had taken place. Moderate scouring had occurred, grass, trees, and shrubs grew to the water edge and algae grew in the water. No evidence of aquatic fauna was observed. The day was clear and bright with cirrus clouds. Winds were southerly, light to moderate. No precipitation was recorded during the preceding week.

Temperature:	23°C	air
	17°C	water
	18°C	bottom sediment
Midstream velocity:	0.66	fps

Appearance of Water in Bulk: The water was turbid and had a greenish-brown color with some surface floc. The river water and bottom sediment both had a strong anaerobic odor.

Soil Sampling Site Location: On both banks, the soil samples were taken approximately 600 feet upstream of the Belt Line Road Bridge - 100 feet inland on the right and 100 feet inland on the left.

Sources of Pollution:

Point Sources: Eleven point sources of pollution were identified along the 28 mile reach upstream from Site No. 6. The STP near CRM 495 (effluent 93.8 MGD) was considered the major source. Two STPs (including the one just cited) and 2 power plants discharged directly into the river. Three tributaries brought pollution from 4 power plants, 2 STPs, and a petroleum plant. The combined effluent was approximately 103 MGD. Carry over pollution will have an effect at this point but will be insignificant when compared with the point source discharge in the reach directly upstream from the site.

Land Use Activity Along the Reach:

41%	pasture and range
3%	forest
46%	crop land
6%	urban
4%	other

Storm Runoff: Nonpoint source pollution from urban runoff is still important at this point in the river despite the fact that the cities are some distances upstream. The tributaries entering the river near the sampling site carry urban runoff.

Sampling Site No. 7 Planning Sub-area 5

Sampled on Friday, January 28, 1977, 10:37 A.M.

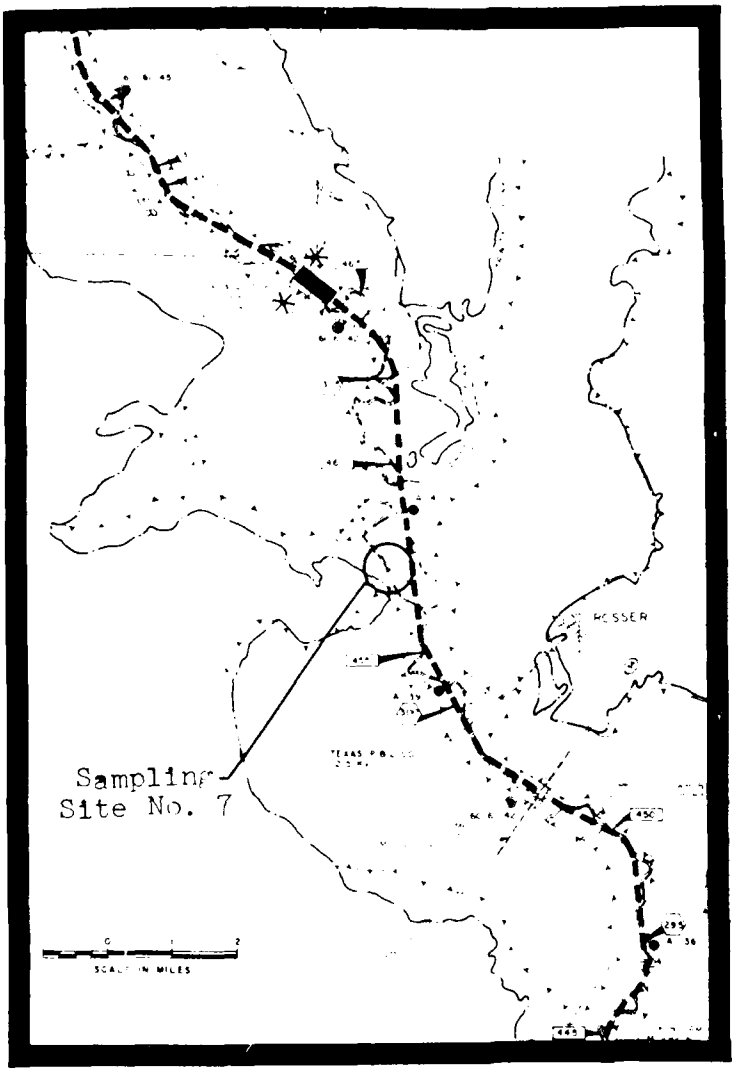
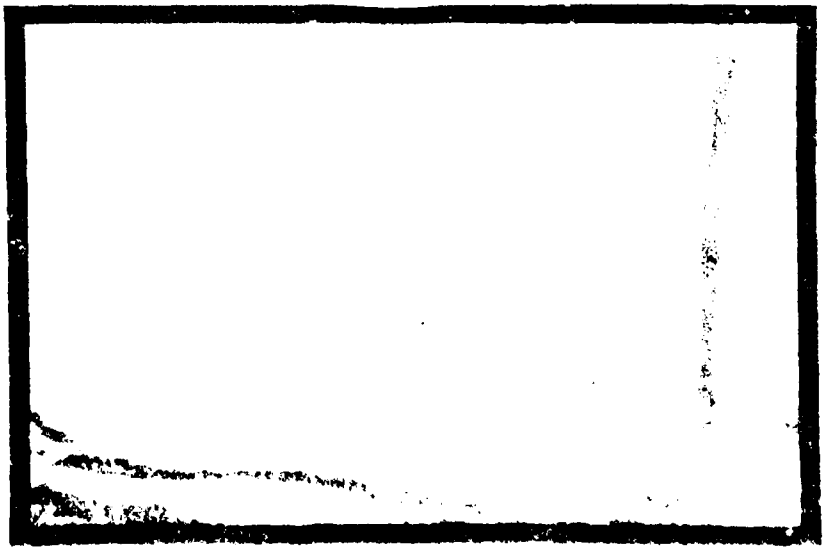


FIGURE B-21. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 7 (Corps River Mile 456.5; Channel Mile 302.2)

FIGURE B-22.

ACCESS PHOTOGRAPH FROM THE PROPERTY OF JIM WISHON, BRISTOL, TEXAS



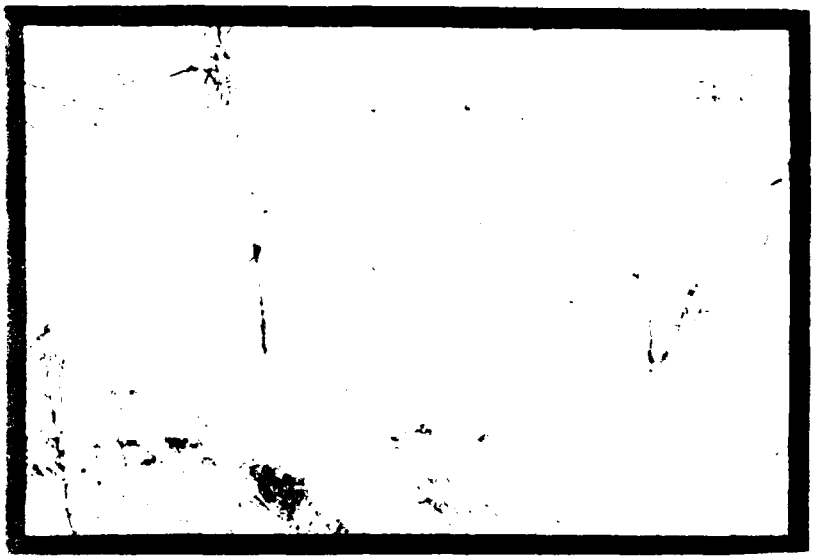


FIGURE B-23. SAMPLING SITE NO. 7. VIEW OF THE RIVER

FIGURE B-24. SAMPLING SITE NO. 7. ANIMAL TRACKS ALONG THE RIVER BANK

Description of Sampling Site No. 7

Access: The boat was launched from the right bank of the river on the west side of some pastureland belonging to Mr. Jim Wishon of Bristol, Texas. The site was reached by traveling approximately 200 feet upstream from the point of launching.

Physical Description: The river was moderately wide (~50 feet, 200 feet), moderatley deep (~10 feet, ~25), and had a strong current. Only a few tree trunks and branches obstructed flow. Extensive mudsliding and scouring was observed on the right bank. Also on the right bank, 200 foot shale outcropping acted as a natural spring. The left bank exhibited extensive scouring. Both banks were composed largely of sandy clay. Trees, shrubs, and grasses grew to within 30 feet of the water line. There was no evidence of aquatic fauna or flora. The day was bright, partly cloudy (5-10%), and windy (20-25 MPH from NW). Only trace amounts of precipitation were recorded during the preceding week.

Temperature:	12°C	air
	14°C	water
	14°C	bottom sediment
Midstream velocity:	1.73	fps

Appearance of Water in Bulk: The water was a greenish-brown with some foam, gas bubbles, floc, black rise, and toilet paper floating in it. Turbidity was high and visibility low. An earthy smell was present above the river water and the bottom sediment had a slight odor.

Soil Sampling Site Location: On both banks, the soil samples were taken at the site - 120 feet inland on the right and 90 feet inland on the left.

Sources of Pollution:

Point Sources: The major point source pollution discharging directly into the 22 mile reach of river upstream from the site, is attributed to the [illegible] Creek STP (effluent 7 MGD). Also, the East Fork of the Trinity joins the river just upstream from this site and carries with it discharges from 7 STPs (combined effluent approximately 111 MGD). Numerous small STPs (combined effluent of 1 MGD) discharged into this reach upstream from Site No. 7. The total point source effluent was approximately 119 MGD. Pollution carried over from the upper reaches also appears to have a significant effect at this site.

Land Use Activity Along the Reach:

41	pasture and range
3	forest
46	crop land
6	urban
-	other

Storm Runoff: Because this site is 30 miles downstream of the major urban area, runoff from crop land and pasture has significant effect.

Sampling Site No. [illegible] Planning Sub-area 4

Sampled on Monday, December 27, 1976, [illegible] A.M.

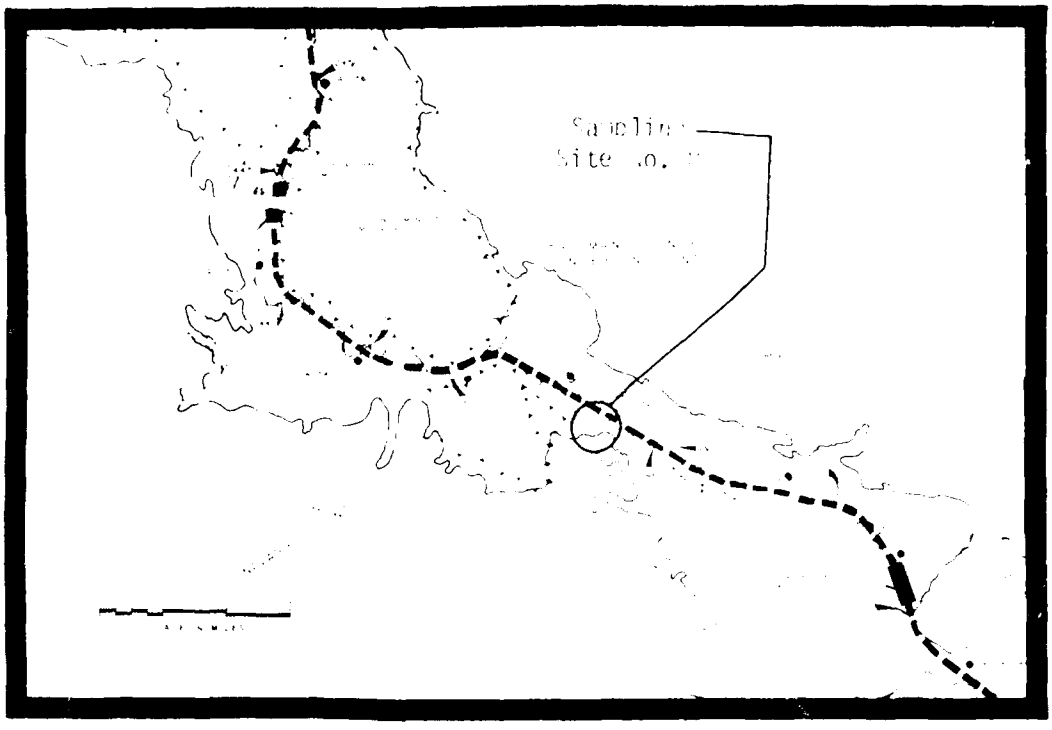


FIGURE B-25. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE [illegible]
(Corps River Mile 491.5; Channel Mile 266.[illegible]

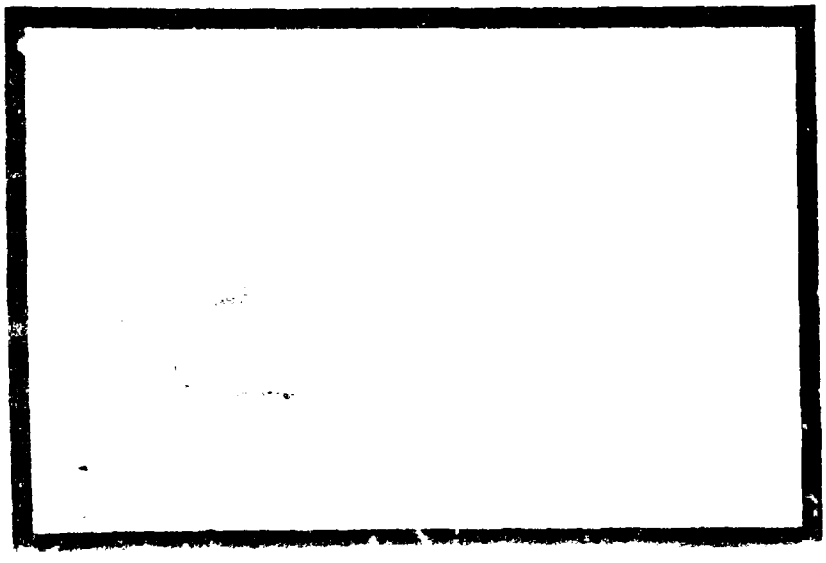
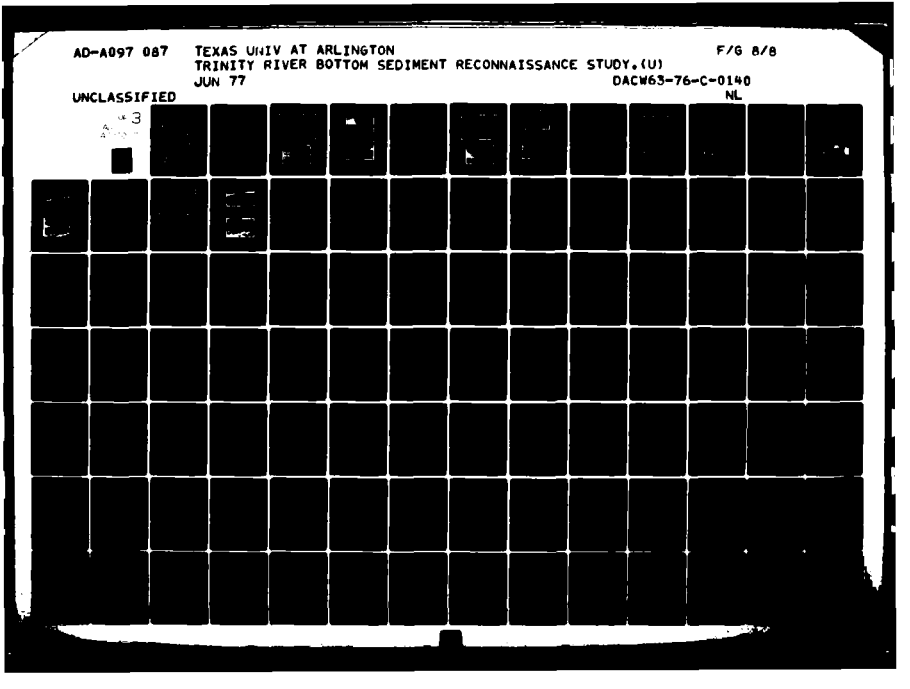


Figure B-26. SAMPLING SITE NO. [illegible] A. U.S. PHOTOGRAPH.
BOAT LAUNCHING SITE

AD-A097 087 TEXAS UNIV AT ARLINGTON F/G 8/8
TRINITY RIVER BOTTOM SEDIMENT RECONNAISSANCE STUDY.(U)
JUN 77 DACW63-76-C-0140
UNCLASSIFIED NL



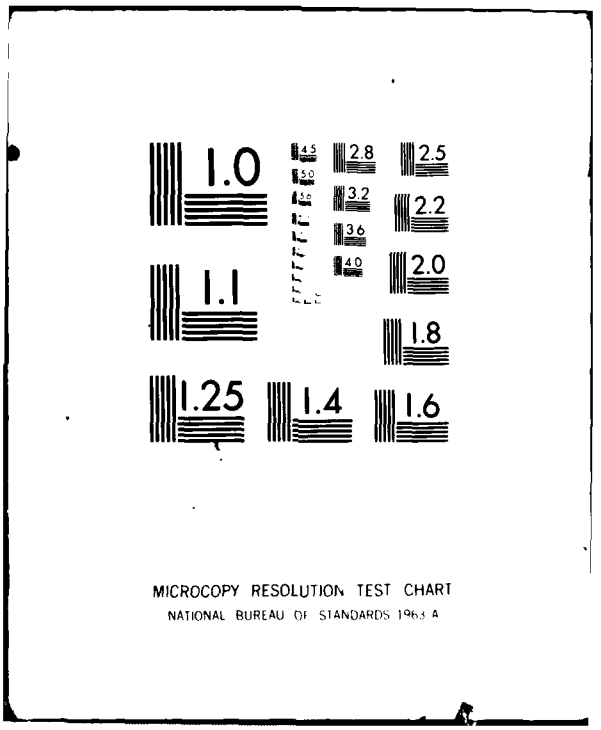

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

FIGURE B-27. SAMPLING SITE NO. 8. VIEW OF THE RIVER

FIGURE B-28. SAMPLING SITE NO. 8. OBSTRUCTION IN THE RIVER

Description of Sampling Site No. 8

Access: The boat was launched from the right bank, downstream of the SH 85 Bridge. The site was located 500 feet upstream of the SH 85 Bridge.

Physical Description: The river was moderately wide (>50 feet, <100 feet), shallow (<10 feet), and swift. A few stumps and some debris obstructed flow, but not significantly. There were mud slides and slumping on the dark gray clay banks. Forest lined the banks and trees and shrubs grew to within 35 feet of the water line. Algae grew on the clay under the water surface. No aquatic fauna was observed. The day was clear and bright with high cirrus clouds and a light wind o 5-10 MPH from the N. No precipitation was recorded during the preceding week.

Temperature:	19°C	air
	15°C	water
	16°C	bottom sediment
Midstream velocity:	1.5	fps

Appearance of Water in Bulk: The water had a dark grayish-green color. Turbidity was low and there was little suspended matter. Visibility was approximately 18 inches. A faint putrid odor was present.

Soil Sampling Site Location: On the right bank the soil sample was taken approximately 300 feet upstream of the SH 85 Bridge and 150 feet inland. On the left bank, the soil sample was taken 500 feet upstream of the SH 85 Bridge and 200 feet inland.

Sources of Pollution:

Point Sources: Point sources directly discharging into the river along the 25 miles reach upstream from Site No. 8 contribute less than 0.6 MGD and are therefore relatively insignificant. The major point source of pollution is the confluence of the East Fork at CRM 460 (effluent 111 MGD from a combination of 5 STPs). The effect of this pollution is reduced by its travel distance in the Trinity River before Site No. 8.

Land Use Activity Along the Reach:

41%	pasture and range
3%	forest
46%	crop land
6%	urban
4%	other

Storm Runoff: The major nonpoint source of discharge is runoff from pasture and crop land.

Sampling Site No. 9 Planning Sub-area 3
Sampled on Tuesday, December 28, 1976, 9:30 A.M.

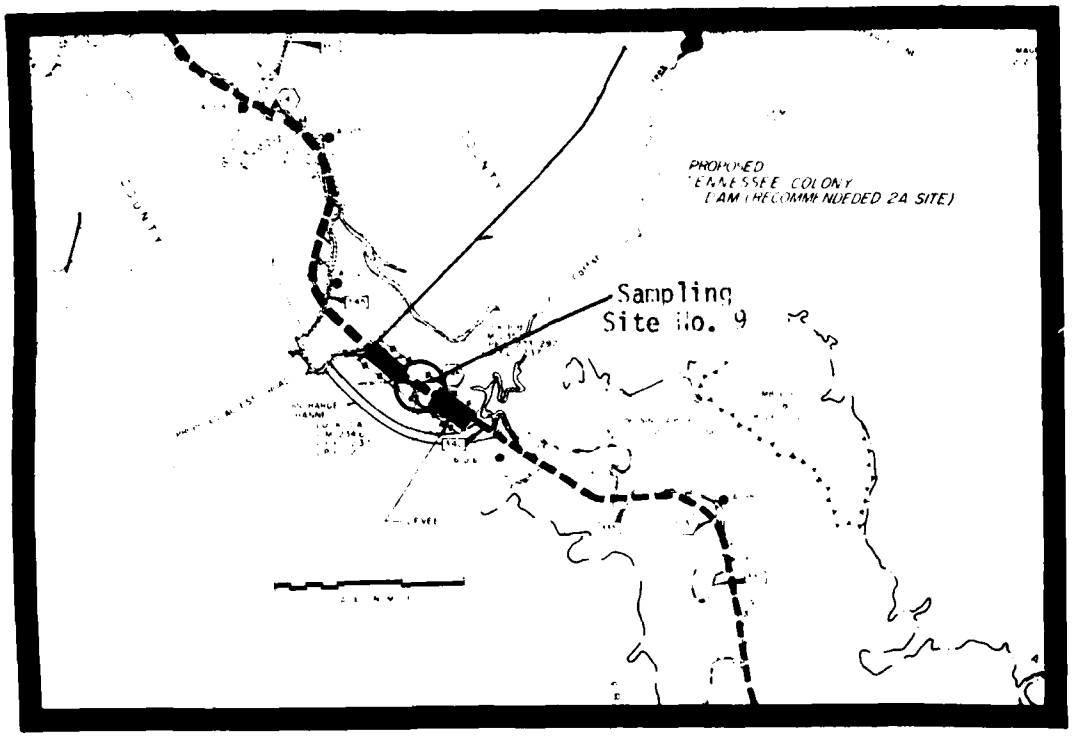


FIGURE B-29. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 9 (Corps River Mile 341.0; Channel Mile 234.7)

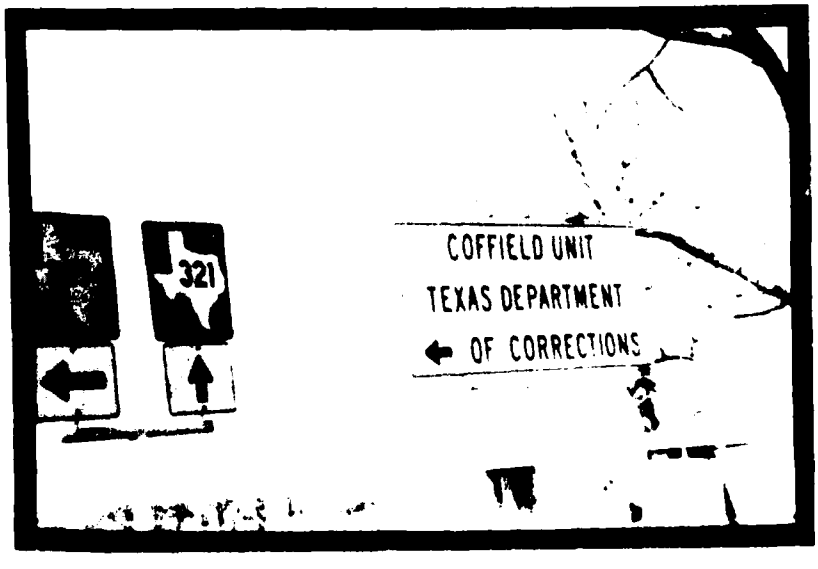


FIGURE B-30. SAMPLING SITE NO. 9. LANDMARK PHOTOGRAPH. SIGN SHOWING THE ENTRANCE TO COFFIELD PRISON FARM

FIGURE B-31. SAMPLING SITE NO. 9. ACCESS PHOTOGRAPH. APPROXIMATELY 2 MILES UPSTREAM OF PROPOSED LAKE TENNESSEE COLONY DAM SITE

FIGURE B-32. SAMPLING SITE NO. 9. VIEW OF THE RIVER

Description of Sampling Site No. 9

Access: The boat was launched from the left bank at a low water crossing on the Trinity River approximately 4 miles Southwest of the Coffield State Prison Farm. The site was located approximately 1000 feet downstream from the crossing.

Physical Description: The river was moderately wide (>50 feet, <100 feet), and moderately deep (>10 ft, <25 ft). The site was located downstream of some mild rapids. The debris obstructing flow consisted of concrete bridge sections, rip-rap, tree trunks and branches. The banks were sandy silt which exhibited ripple marks. The area was heavily forested and trees grew to within 15 feet of the water in places. Undergrowth consisting of thorn bushes and creeping vines grew to within 50 feet of the water. Fish were observed in the water and freshwater mussel shells were found along the banks. The day was clear, calm, and bright with no clouds. Only trace precipitation was recorded during the preceding week.

Temperature	16°C	air
	14°C	water
	15°C	bottom sediment
Midstream velocity:	0.78	fps

Appearance of Water in Bulk: The water appeared fairly clean. There was some turbidity with visibility only 6 inches. A slight fishy odor was present at the site.

Soil Sampling Site Location: Soil samples were taken from both banks of the river at the sampling site. On the right a sample was taken approximately 150 feet inland and on the left bank approximately 50 feet inland.

Sources of Pollution:

Point Sources: Several point sources were identified on the 90 mile reach upstream from Site No. 9. The largest of these had a flow of 1MGD and the combined flow from all point sources was only slightly over 2MGD. Since this pollution occurred over a 90 mile reach and most was discharged from tributaries, point source pollution was relatively low. The effect of upstream pollution was relatively insignificant at this point due to the distance from major sources of pollution.

Land Use Activity Along the Reach:

42%	pasture and range
32%	forest
20%	crop land
4%	urban
3%	other

Storm Runoff: The predominant runoff is drainage from farmland and forest. Because point source pollution is small at this sight, nonpoint source runoff may have a significant effect.

Sampling Site No. 10 Planning Sub-area 3

Sampled on Friday, January 28, 1977, 2:43 P.M.

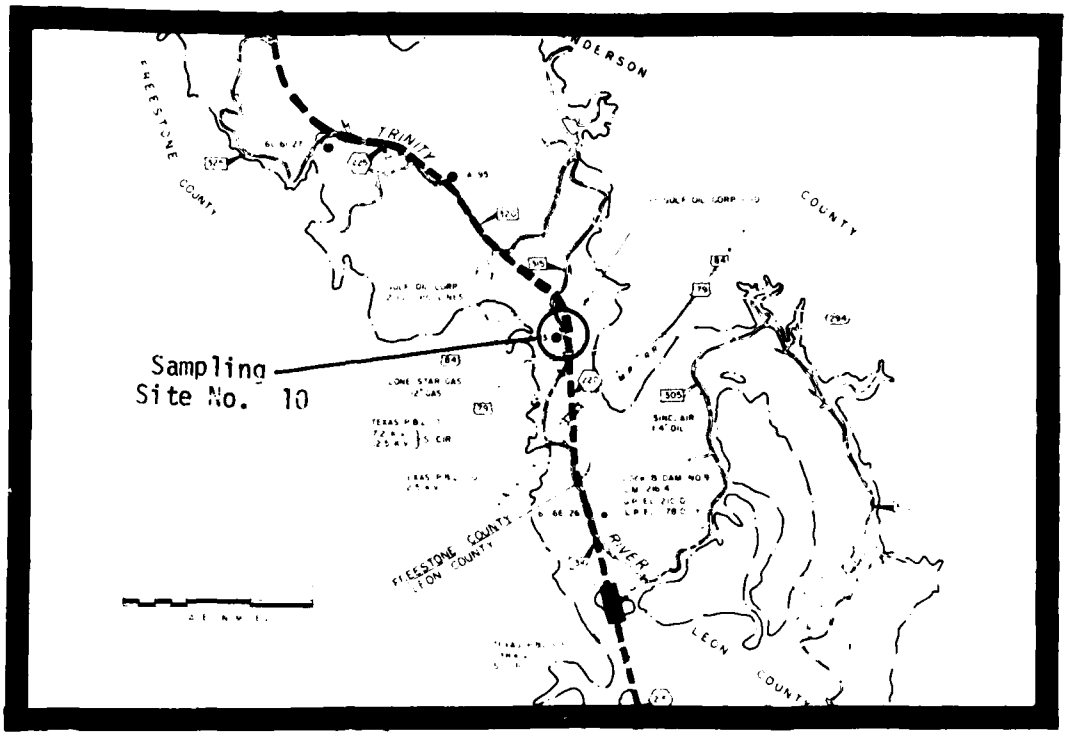


FIGURE B-33. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 10 (Corps River Mile 313.0; Channel Mile 220.9)

FIGURE B-34. SAMPLING SITE NO. 10. ACCESS PHOTOGRAPH

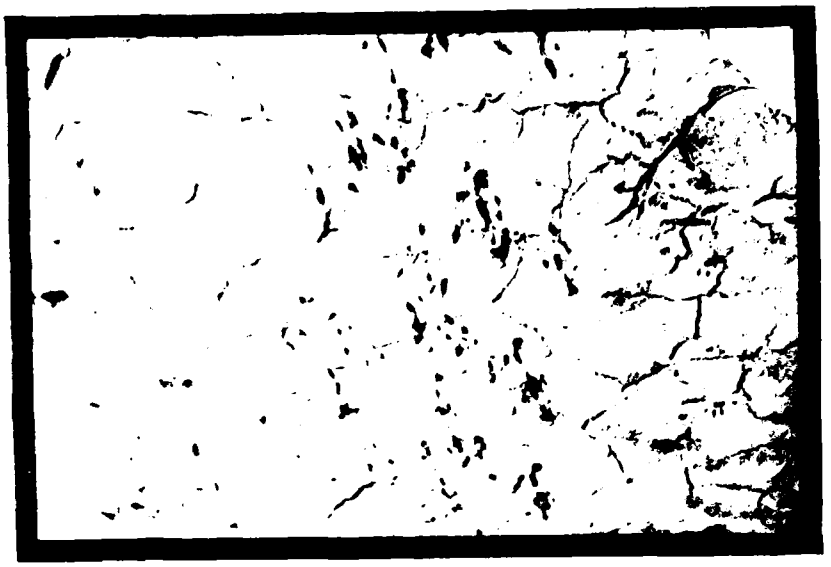


FIGURE B-35. SAMPLING SITE NO. 10. ANIMAL TRACKS ALONG THE BANKS

FIGURE B-36. SAMPLING SITE NO. 10. VIEW OF THE RIVER AND BANKS

Description of Sampling Site No. 10

Access: The boat was launched from the right bank, downstream of the US Highway 84 Bridge. The site was located 400 feet upstream of the US Highway 84 Bridge.

Physical Description: The river was moderately wide (>50 feet, <100 feet), moderately deep (>10 feet, >25 feet), and had a strong current. There were only a few minor obstructions. Mud slides had occurred on the right bank and both banks exhibited extensive scouring. The banks were sand and clay with laterite and limestone outcrops on the left bank. Trees and shrubs grew down to the water line on both banks. No evidence of aquatic fauna was seen. The day was bright and clear with high cirrus clouds and a wind of 10-15 MPH from the N. No precipitation was recorded during the preceding week.

Temperature:	16°C	air
	14°C	water
	15°C	bottom sediment
Midstream velocity:	2.1	fps

Appearance of Water in Bulk: The water was a greenish-brown color with a little foam and low turbidity. No odor was detected in the water, but the bottom sediments had a slightly anaerobic odor.

Soil Sampling Site Location: On the right bank, the soil sample was taken 400 feet upstream of the US Highway 84 Bridge, 80 feet inland. On the left bank, the soil sample was taken 30-50 feet downstream of the bridge, 30 feet inland.

Sources of Pollution:

Point Sources: Eight point sources of pollution were identified in the 28 mile reach upstream of Site No. 10. The total flow from these sources is approximately 1.3 MGD with an STP at CRM 317 the major contributor. Point source pollution at this site is relatively low, and because it is 145 miles downstream of the major point sources of pollution there is no significant carry-over pollution.

Land Use Activity Along the Reach:

42%	pasture
32%	forest
20%	crop land
4%	urban
3%	other

Storm Runoff: Drainage from the agricultural and forest lands along the reach has significant effect.

Sampling Site No. 11 Planning Sub-area 3

Sampled on Tuesday, December 28, 1976, 1:50 P.M.

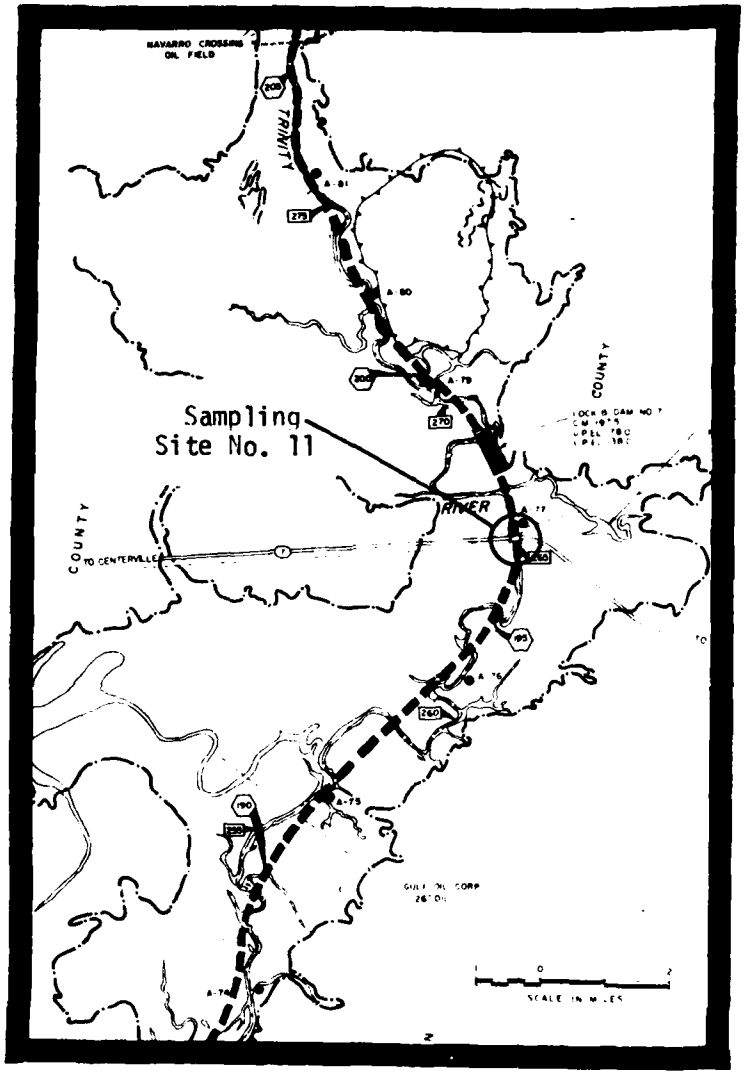


FIGURE B-37. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 11
(Corps River Mile 265.0; Channel Mile 196.5)

FIGURE B-38. SAMPLING SITE NO. 11. ACCESS PHOTOGRAPH. LAUNCHING THE BOAT FROM A PRIVATE RAMP

FIGURE B-39. SAMPLING SITE NO. 11. ABANDONED LOCK AND DAM

Description of Sampling Site No. 11

Access: The boat was launched from the right bank, upstream of the SH 7 Bridge from a fisherman's ramp. The site was located 150 feet downstream of the SH 7 Bridge and 500 feet downstream of an abandoned lock and dam.

Physical Description: The river was wide (>100 feet), moderately deep (>10 feet, <25 feet), and swift. Submerged stumps were present but they did not obstruct flow. The banks were heavily silted and littered with trees and branches. The right bank showed evidence of extensive scouring. Trees, shrubs, and grasses frequently grew to the water line. Bass and catfish were abundant in the river. The day was clear to partly cloudy with a northerly wind (10-15 MPH). No significant precipitation was recorded during the preceding week.

Temperature:	22°C	air
	14°C	water
	14°C	bottom sdeiment
Midstream velocity:	1.3	fps

Appearance of Water in Bulk: The water had a greenish-brown color and appeared clean. Visibility was good with low turbidity. There was no detectable odor in the water or sediment.

Soil Sampling Site Location: On the right bank, the soil sample was taken approximately 350 feet upstream of the SH 7 Bridge, 150 feet inland. On the left bank, the soil sample was taken about 150 feet downstream of the SH 7 Bridge, 100 feet inland.

Sources of Pollution:

Point Sources: Eight point sources of pollution were identified in the 49 mile reach upstream from Site No. 11. The 7 small STPs and 1 small WTP had a combined effluent of approximately 1.8 MGD and thus point source pollution at this site is minimal. Carry-over pollution is also insignificant because Site No. 11 is 195 downstream of any major point source of pollution.

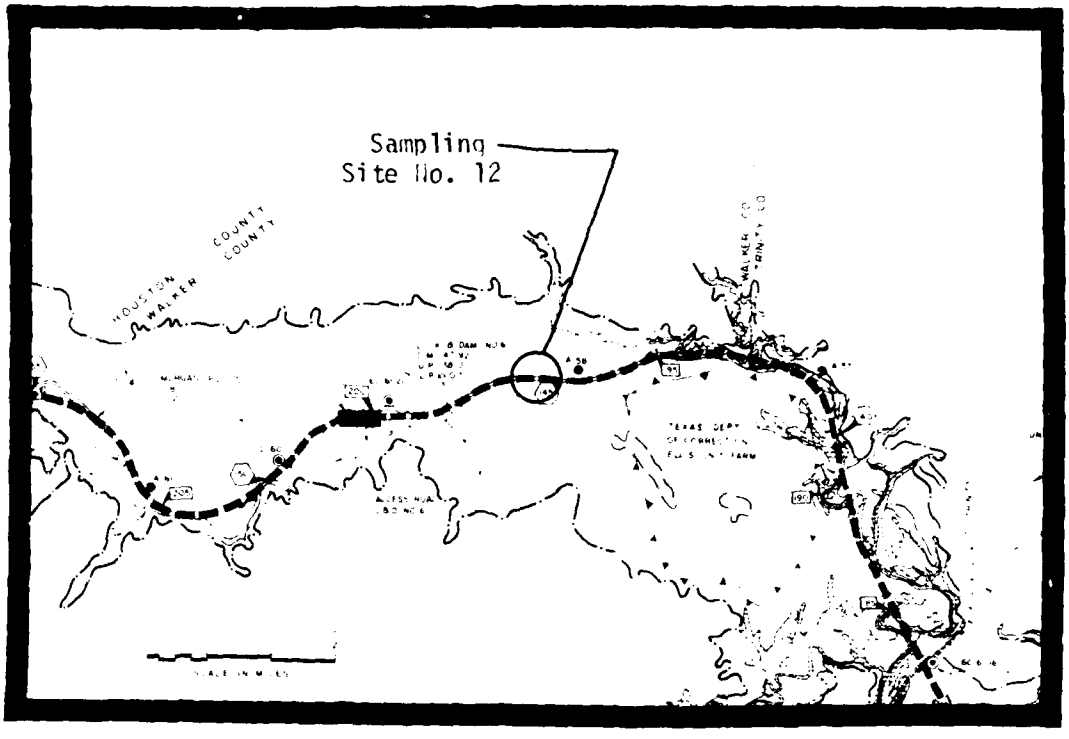
Land Use Activity Along the Reach:

42%	pasture and range
32%	forest
20%	crop land
4%	urban
3%	other

Storm Runoff: Storm runoff from the agricultural land along the reach above Site No. 11 has a major effect upon water and sediment quality.

Sampling Site No. 12 Planning Sub-area 3

Sampled on Friday, February 18, 1977, 10:30 A.M.



FOGIRE B-40. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 12 (Corps River Mile 197.0; Channel Mile 145.0)

FIGURE B-41. SAMPLING SITE NO. 12. LANDMARK PHOTOGRAPH. ENTRANCE TO DEEP RIVER PLANTATION

FIGURE B-42. SAMPLING SITE NO. 12. LANDMARK PHOTOGRAPH. ABANDONED DEEP RIVER RESTAURANT

FIGURE B-43. SAMPLING SITE NO. 12. VIEW OF THE RIVER

Description of Sampling Site No. 12

Access: The boat was launched from a boat ramp on the left bank of the river at Deep River Plantations and near the Deep River Waterfront Restaurant. The site was reached by traveling approximately 200 feet upstream.

Physical Description: The river was very wide (>200 feet), deep (>50 feet), and swift. The banks were of sandy clay. Some evidence of scouring. Trees and grass were plentiful and grew near the water line. The river appeared to be under flood conditions and many trees were partially submerged. Large fish and blood worms were found in the water. The day was bright with a slight overcast and mild wind. No precipitation was recorded during the preceding week but there were heavy rains the weeks before that.

Temperature:	24°C	air
	16°C	water
	16°C	bottom sediment
Midstream velocity:	2.92	fps

Appearance of Water in Bulk: The water was brown and muddy but appeared free of pollution. High turbidity resulted in visibility of approximately 1 inch. The water had no detectable odor, but the bottom sediment had a slight fishy odor.

Soil Sampling Site Location: On both banks, the soil samples were taken at the site, 100 feet inland on the right and 200 feet inland on the left.

Sources of Pollution:

Point Sources: Eight point sources of pollution were identified along the 68 mile reach upstream from Site 12. All 8 sources were small STPs with a combined effluent of less than 1.1 MGD. Point source pollution is therefore insignificant at this point. Carry-over pollution is also insignificant because the site is 260 miles downstream of any major sources of pollution.

Land Use Activity Along the Reach:

20%	pasture and range
70%	forest
4%	crop land
3%	urban
3%	other

Storm Runoff: The majority of the land from which runoff discharges into this reach is covered with forest.

Sampling Site No. 13 Planning Sub-area 2

Sampled on Friday, February 18, 1977, 2:30 P.M.

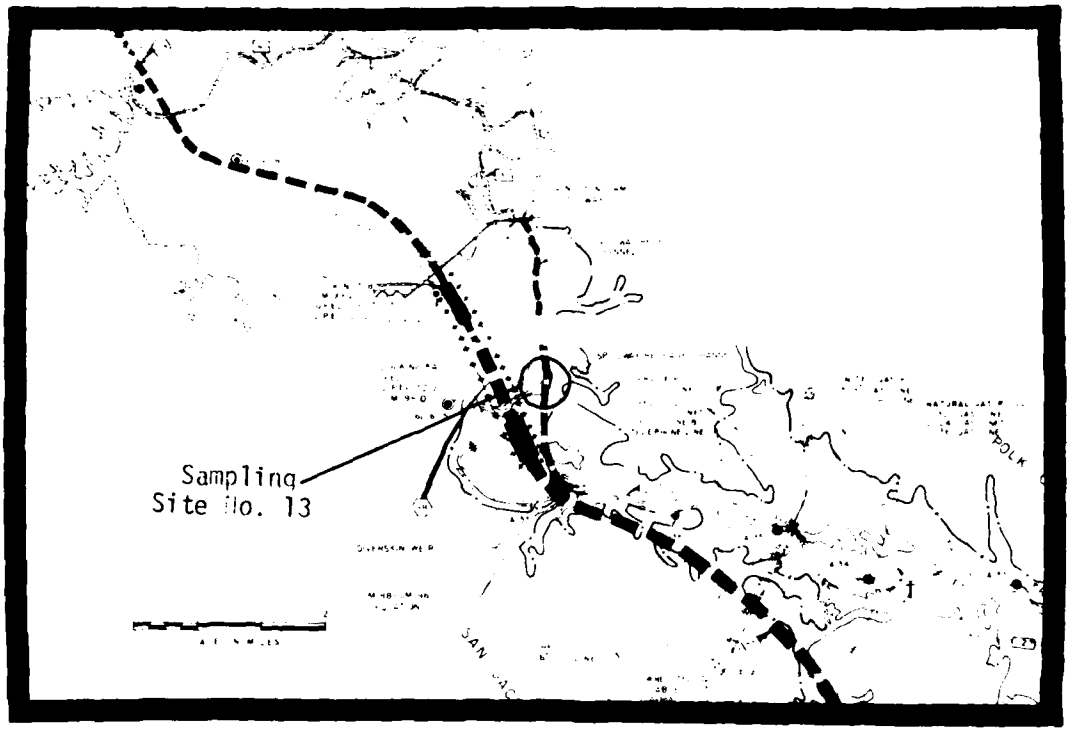


FIGURE B-44. CHANNEL ALIGNMENT AND LANDMARK MAP OF SAMPLING SITE NO. 13
(Corps River Mile 125.0; Channel Mile 98.0)

FIGURE B-45. SAMPLING SITE NO. 13. ACCESS PHOTOGRAPH.
LAUNCHING THE BOAT INTO A SMALL DRAINAGE DITCH

FIGURE B-46. SAMPLING SITE NO. 13. VIEW OF THE RIVER

FIGURE B-47. SAMPLING SITE NO. 13. FOAM ON RIVER SURFACE NEAR BANKS

Description of Sampling Site No. 13

Access: The boat was launched into a small drainage ditch that enters the river from the left bank. The drainage ditch extends back into the land belonging to Mr. Phillips whose property is in the Riviera Estates near Livingston, Texas. The sampling site was reached by traveling approximately 1/4 mile downstream from Mr. Phillips' property.

Physical Description: The river was wide (>200 feet), moderately deep (>10 feet, <25 feet) and swift. The banks were of silty sands and showed no evidence of scouring. No obstructions to flow were seen. Trees, shrubs, and grasses were abundant, and algae grew in the river. Many small fish were observed. The river is used extensively for fishing, boating, and water contact sports. The day was clear and bright with no wind. No precipitation was recorded during the preceding week but there were heavy rains the week before that. Discharge from Lake Livingston was approximately 25,200 cfs.

Temperature:	23°C	air
	16°C	water
	16°C	bottom sediment
Midstream velocity:	4.19	fps

Appearance of Water in Bulk: The water was green and appeared clean. Turbidity was high and visibility low. The water had a fishy odor.

Soil Sampling Site Location: On the right bank, the soil sample was taken at the site, 150 feet inland. On the left bank, the soil sample was taken 0.5 mile downstream of the Lake Livingston Dam, 300 feet inland.

Sources of Pollution:

Point Sources: There are no significant point sources of pollution in the reach upstream from Site No. 13. The entire discharge is from Lake Livingston.

Land Use Activity Along the Reach:

24%	pasture and range
74%	forest
1%	crop land
0.5%	urban
0.5%	other

Storm Runoff: The primary runoff which enters Lake Livingston is from forest land.

APPENDIX C

METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA

CLIMATOLOGICAL STATIONS AND OBSERVERS BY COUNTY

County	Station	Observer
Wise	1. Bridgeport	Mrs. Betty Hembree
	2. Boyd	Bobby Don Fowler
	3. Decatur	Ansel L. Fortenberry
Freestone	1. Long Lake 5 SW	Noyl Anders
Anderson	1. Palestine	Mrs. Jimmie Dale Trezise
Leon	1. Buffalo	Henry M. Harris
	2. Centerville	Royce Wilson
	3. Jewett	Mrs. Elna E. Leazar
Houston	1. Crockett	James H. Gibbs
	2. Lovelady	Lester Jones
Madison	1. Madisonville	Ross Madole
Trinity	1. Groveton	T. P. Walton, Jr.
Denton	1. Roanoke	George R. Jones
Kaufman	1. Crandall	Mrs. Vallie Sue Sorrells
	2. Rosser	Mrs. Opal L. Taliaferro
Angelina	1. Lufkin FAA AP	Lufkin FAA AP
San Jacinto	1. Coldspring 5 SSW	Leroy S. Dibney
Tarrant	1. Arlington	Charles I. Hawkes
	2. Benbrook Dam	Prof. Eng. Benbrook Proj.
	3. Dal-Ft.W Reg. WSMO AP	Weather Service Met. Obs'y.
	4. Grapevine Dam	US Corps of Engineers
Dallas	1. Carrollton 2 N	Mrs. Betty L. Sumner
	2. Dallas FAA AP	FAA Flight Service Station
	3. Richardson	City of Richardson
Ellis	1. Avalon	Herschel H. Smith
	2. Bardwell Dam	Corps of Engineers

TABLE C-1. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 1. SAMPLED ON NOVEMBER 5, 1976.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		Benbrook	Roanoke	Bridgeport	Boyd	Decatur
Precipitation (inches)	10/30	0.98	1.00	1.30	1.13	0.09
	10/31	0.10	0.00	0.00	0.00	0.00
	11/1	0.00	0.00	0.00	0.00	0.00
	11/2	0.00	0.00	0.00	0.00	0.00
	11/3	0.00	0.00	0.00	0.00	0.00
	11/4	0.00	0.00	0.00	0.00	0.00
	11/5	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	11/5	63	-	-	-	-
Minimum Temperature (°F)	11/5	33	-	-	-	-
Average Temperature (°F)	11/5	48*	-	-	-	-

HYDROLOGICAL DATA — Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8048000 North Main, Viaduct Fort Worth	0.69	519.93	27
Downstream at 8049500 Belt Line Grand Prairie	1.04	411.46	177
At sampling site			86

FIELD TEST DATA: (Obtained within 5 hours) — Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	4.2	+170	7.6	68	20
Bottom Sediments	0	-180	7.3	68.9	

*Average of maximum and minimum.

TABLE C-2. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 2. SAMPLED ON NOVEMBER 5, 1976.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		Benbrook	Arlington	Bridgeport	Roanoke	Boyd
Precipitation (inches)	10/30	0.98	0.10	1.30	1.00	1.13
	10/31	0.10	0.00	0.00	0.00	0.00
	11/1	0.00	0.00	0.00	0.00	0.00
	11/2	0.00	0.00	0.00	0.00	0.00
	11/3	0.00	0.00	0.00	0.00	0.00
	11/4	0.00	Not Available	0.00	0.00	0.00
	11/5	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	11/5	63	-	-	-	-
Minimum Temperature (°F)	11/5	33	-	-	-	-
Average Temperature (°F)	11/5	48*	-	-	-	-

HYDROLOGICAL DATA — Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8048000 North Main Viaduct Fort Worth	0.69	519.93	27
Downstream at 8049500 Belt Line Grand Prairie	1.04	411.46	177
At sampling site			116

FIELD TEST DATA: (Obtained within 2 hours) — Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	5.5	+230	7.7	68.0	17
Bottom Sediments	0	-188	7.0	68.9	

*Average of maximum and minimum.

TABLE C-3. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 3. SAMPLED ON NOVEMBER 8, 1976.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		Arlington	D/FW Airport	Benbrook	Grapevine Dam	Roanoke
Precipitation (inches)	11/2	0.00	0.00	0.00	0.00	0.00
	11/3	0.00	0.00	0.00	0.00	0.00
	11/4	Not Available	0.00	0.00	0.00	0.00
	11/5	0.00	0.00	0.00	0.00	0.00
	11/6	0.00	0.00	0.00	0.00	0.00
	11/7	0.00	0.00	0.00	0.00	0.00
	11/8	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	11/8	-	65	65	65	-
Minimum Temperature (°F)	11/8	-	36	31	32	-
Average Temperature (°F)	11/8	-	50.5*	48	43.5	-

HYDROLOGICAL DATA			
Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8049500 Belt Line Grand Prairie	0.97	411.39	156
Downstream at 8057000 Commerce Street Viaduct Dallas	10.81	378.83	247
At sampling site			180

FIELD TEST DATA: (Obtained within 2 hours)					
Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	5.4	+132	7.6	67	18
Bottom Sediments	0	-90	7.2	63.5	

*Average of maximum and minimum.

TABLE C-4. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 4. SAMPLED ON DECEMBER 3, 1976.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		D/FW	Arlington	Benbrook	Grapevine Dam	Roanoke
Precipitation (inches)	11/27	0.00	0.00	0.00	0.00	0.00
	11/28	Trace	0.00	Trace	0.00	0.00
	11/29	0.00	0.00	0.00	0.00	0.00
	11/30	0.00	0.00	0.00	0.00	0.00
	12/1	0.00	0.00	0.00	0.00	0.00
	12/2	0.00	0.00	0.00	0.00	0.00
	12/3	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	12/3	72	-	-	58	-
Minimum Temperature (°F)	12/3	30	-	-	26	-
Average Temperature (°F)	12/3	51*		-	42	-

HYDROLOGICAL DATA

Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 80495 00 Belt Line Grand Prairie	1.00	411.42	165
Downstream at 80570 00 Commerce Street Viaduct Dallas	11.02	379.04	260
At sampling site			220

FIELD TEST DATA: (Obtained within 4 hours)

Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	5.5	+155	7.6	59.9	41
Bottom Sediments	0	-360	7.0	59.9	

*Average of maximum and minimum.

TABLE C-5. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 5. SAMPLED ON DECEMBER 3, 1976.

DATA	DATE	METEOROLOGICAL DATA				
		CLIMATOLOGICAL STATIONS				
		D/FW	Arlington	Benbrook	Grapevine Dam	Carrollton
Precipitation (inches)	11/27	0.00	0.00	0.00	0.00	0.00
	11/28	Trace	0.00	Trace	0.00	0.00
	11/29	0.00	0.00	0.00	0.00	0.00
	11/30	0.00	0.00	0.00	0.00	0.00
	12/1	0.00	0.00	0.00	0.00	0.00
	12/2	0.00	0.00	0.00	0.00	0.00
	12/3	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	12/3	72	-	-	58	-
Minimum Temperature (°F)	12/3	30	-	-	26	-
Average Temperature (°F)	12/3	51*	-	-	44	-

HYDROLOGICAL DATA			
Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8049500 Belt Line Grand Prairie	1.00	411.42	165
Downstream at 8057000 Commerce Street Viaduct, Dallas	11.02	379.04	260
At sampling site			230

FIELD TEST DATA: (Obtained within 4 hours)					
Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	6.3	+160	7.5	59	42
Bottom Sediments	0	-180	7.0	62.6	

*Average of maximum and minimum.

TABLE C-6. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 6. SAMPLED ON DECEMBER 27, 1976.

DATA	DATE	METEOROLOGICAL DATA				
		CLIMATOLOGICAL STATIONS				
		D/FW	Richardson	Grapevine Dam	Arlington	Carrolton
Precipitation (inches)	12/21	0.00	0.00	0.00	0.00	0.00
	12/22	0.00	0.00	0.00	0.00	0.00
	12/23	0.00	0.00	0.00	0.00	0.00
	12/24	0.00	0.00	0.00	0.00	0.00
	12/25	0.00	0.00	Trace	0.00	0.00
	12/26	0.00	0.00	0.00	0.00	0.00
	12/27	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	12/27	70	-	66	-	-
Minimum Temperature (°F)	12/27	36	-	30	-	-
Average Temperature (°F)	12/27	53*	-	48	-	-

HYDROLOGICAL DATA

Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8057410 South Loop 12 Dallas	6.30	372.19	623
Downstream at 8062500 State Hwy 34 Southwest of Rosser	5.03	307.68	794
At sampling site			680

FIELD TEST DATA: (Obtained within 4 hours)

Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	7.1	+110	7.6	62.6	40
Bottom Sediments	0	-170	6.8	64.6	

*Average of maximum and minimum.

TABLE C-7. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 7. SAMPLED ON JANUARY 28, 1977.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		Richardson	D/FW Airport	Grapevine Dam	Arlington	Carrolton
Precipitation (inches)	1/22	0.31	0.09	0.00	0.00	0.00
	1/23	0.12	0.19	0.00	0.16	0.31
	1/24	0.00	0.00	0.14	0.10	0.12
	1/25	0.00	0.00	0.00	0.00	0.00
	1/26	0.00	0.00	0.00	0.00	0.00
	1/27	0.00	0.00	0.00	0.00	0.00
	1/28	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	1/28	-	41	49	-	-
Minimum Temperature (°F)	1/28	-	25	30	-	-
Average Temperature (°F)	1/28	-	33*	39.5*	-	-

HYDROLOGICAL DATA			
Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8057410 South Loop 12 Dallas	7.06	372.95	816
Downstream at 8062500 State Highway 34 South West of Rosser	6.61	309.26	1300
At sampling site			1240

FIELD TEST DATA: (Obtained within 8 hours)					
Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	4.6	-185	7.4	57.2	72
Bottom Sediments	0	-30	7.2	57.2	

*Average of maximum and minimum.

TABLE C-8. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 8. SAMPLED ON DECEMBER 27, 1976.

DATA	DATE	METEOROLOGICAL DATA				
		CLIMATOLOGICAL STATIONS				
		D/FW	Bardwell Dam	Crandall	Rosser	Avalon
Precipitation (inches)	12/21	0.00	0.00	Trace	0.00	0.00
	12/22	0.00	0.00	0.00	0.00	0.00
	12/23	0.00	0.00	0.00	0.00	0.00
	12/24	0.00	0.00	0.00	0.00	0.00
	12/25	0.00	0.00	0.00	0.00	0.00
	12/26	0.00	0.00	0.00	0.00	0.00
	12/27	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	12/27	70	64	-	-	-
Minimum Temperature (°F)	12/27	36	32	-	-	-
Average Temperature (°F)	12/27	53*	48*			

HYDROLOGICAL DATA			
Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8062500 State Highway 34 Southwest of Rosser	5.03	307.68	794
Downstream at 8062700 State Highway 31 West of Trinidad.	10.13	185.19	1430
At sampling site			1185

FIELD TEST DATA: (Obtained within 6 hours)					
Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	6.7	+102	7.6	59	32
Bottom Sediments	0	-130	7.1	60.8	

*Average of maximum and minimum.

TABLE C-9. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 9. SAMPLED ON DECEMBER 28, 1976.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		Palestine	Longlake 5 SW	Rosser	Avalon	Bardwell Dam
Precipitation (inches)	12/22	0.00	0.00	0.00	0.00	0.00
	12/23	0.00	0.00	0.00	0.00	0.00
	12/24	0.00	0.00	0.00	0.00	0.00
	12/25	0.03	Trace	0.00	0.00	0.00
	12/26	Trace	0.00	0.00	0.00	0.00
	12/27	0.00	0.00	0.00	0.00	0.00
	12/28	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	12/28	64	-	-	-	67
Minimum Temperature (°F)	12/28	41	-	-	-	38
Average Temperature (°F)	12/28	52.5*	-	-	-	52.5

HYDROLOGICAL DATA

Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8062700 State Highway 31 West of Trinidad	6.81	246.02	738
Downstream at 8065000 US 79 & US 84 Northeast of Oakwood	10.13	185.19	1430
At sampling site			1185

FIELD TEST DATA: (Obtained within 10 hours)

Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	7.5	+220	7.7	55.4	68
Bottom Sediments	0	-175	7.1	57.2	

*Average of maximum and minimum.

TABLE C-10. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 10a. SAMPLED ON JANUARY 28, 1977.

DATA	DATE	METEOROLOGICAL DATA: CLIMATOLOGICAL STATIONS				
		Longlake	Palestine	Groveton	Centerville	Jewett
Precipitation (inches)	1/22	0.00	Trace	0.00	0.00	0.00
	1/23	0.10	0.08	0.16	0.15	0.10
	1/24	0.00	0.08	0.08	0.02	0.05
	1/25	0.00	0.00	0.00	0.00	0.00
	1/26	0.00	0.00	0.00	0.00	0.00
	1/27	0.00	0.00	0.00	0.00	0.00
	1/28	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	1/28	-	68	66	67	-
Minimum Temperature (°F)	1/28	-	34	34	41	-
Average Temperature (°F)	1/28	-	51*	50*	54*	-

HYDROLOGICAL DATA

Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8065000 US 79 and US 84 Northeast of Oakwood	11.7	186.76	1900
Downstream at 8065350 State Highway 7 West of Crockett	10.49	147.08	2260
At sampling site			1900**

FIELD TEST DATA: (Obtained within 3 hours)

Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	8.1	-90	7.7	57.2	79
Bottom Sediments	0	-15	7.0	59	

*Average of maximum and minimum.

**The discharge at 8065000 (corps river mile 313) was 1900 cfs. Estimated corps river mileage of the sampling site was 313.5 miles. Therefore, the discharge at the sampling site was taken as that at USGS station 8065000.

TABLE C-11. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 11. SAMPLED ON DECEMBER 28, 1976.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		Buffalo	Centerville	Jewett	Crockett	Lovelady
Precipitation (inches)	12/22	0.00	0.00	0.00	0.00	0.00
	12/23	0.00	0.00	0.00	0.00	0.00
	12/24	0.00	0.00	0.00	0.00	0.00
	12/25	0.00	0.00	0.00	0.00	0.00
	12/26	0.00	0.00	0.00	0.00	0.00
	12/27	0.00	0.00	0.00	0.00	0.00
	12/28	0.00	0.00	0.00	0.00	0.00
Maximum Temperature (°F)	12/28	-	65	-	63	63
Minimum Temperature (°F)	12/28	-	40	-	32	38
Average Temperature (°F)	12/28	-	52.5*	-	47.5*	50.5*

HYDROLOGICAL DATA

Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8065000 US 79 US 84 Northeast of Oakwood	10.13	185.19	1430
Downstream at 8065350 State Highway 7 West of Crockett	9.83	146.42	1800
At sampling site			1800

FIELD TEST DATA: (Obtained within 7 hours)

Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	8.1	+230	7.1	57.2	125
Bottom Sediments	0	-53	7.1	57.2	

*Average of maximum and minimum.

TABLE C-12. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 12. SAMPLED ON FEBRUARY 18, 1977.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		Crockett	Lovelady	Madisonville	Groveton	Lufkin
Precipitation (inches)	2/12	0.79	0.60	0.48		
	2/13	0	0	0		
	2/14	0	0	0		
	2/15	0	0	0		
	2/16	0	0	0		
	2/17	0	0	0		
	2/18	0	0	0		
Maximum Temperature (°F)	2/18	79	74	78		
Minimum Temperature (°F)	2/18	42	43	47		
Average Temperature (°F)	2/18	60.5*	58.5*	62.5*		

HYDROLOGICAL DATA

Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8065350 State Highway 7 West of Crockett	36.95	173.54**	27,300
Downstream at 8066250 US 59 South of Goodrich	27.49	67.49	25,200
At sampling site			26,340

FIELD TEST DATA: (Obtained within 12 hours)

Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	7.4	+68	7.5	60.8	380
Bottom Sediments	0	-110	7.0	60.8	

*Average of maximum and minimum.

**Water surface elevation at Lake Livingston on sampling day was 131.87.

TABLE C-13. METEOROLOGICAL, HYDROLOGICAL, AND FIELD TEST DATA FOR SAMPLING SITE 13. SAMPLED ON FEBRUARY 18, 1977.

DATA	DATE	METEOROLOGICAL DATA — CLIMATOLOGICAL STATIONS				
		Cold Springs	Crockett	Lovelady	Madisonville	Livingston
Precipitation (inches)	2/12	0.19	0.79	0.60	0.48	
	2/13	0.00	0.00	0.00	0.00	
	2/14	0.00	0.00	0.00	0.00	
	2/15	0.00	0.00	0.00	0.00	
	2/16	0.00	0.00	0.00	0.00	
	2/17	0.00	0.00	0.00	0.00	
	2/18	0.00	0.00	0.00	0.00	
Maximum Temperature (°F)	2/18	72	79	74	78	
Minimum Temperature (°F)	2/18	42	42	43	47	
Average Temperature (°F)	2/18	57*	60.5*	58.5*	62.5*	

HYDROLOGICAL DATA

Gauging Stations	Stage (ft.)	Stage Elevation (ft.)	Discharge (cfs)
Upstream at 8065350 State Highway 7 West of Crockett	36.95	173.54**	27,300
Downstream at 8066250 US 59 South of Goodrich	27.49	67.49	25,200
At sampling site			25,310

FIELD TEST DATA: (Obtained within 8 hours)

Sample	DO (mg/l)	Eh (mv)	pH	Temperature (°F)	Turbidity (JTU)
River Water	11.8	+140	8.1	60.8	32
Bottom Sediments		+135	7.7	60.8	

*Average of maximum and minimum.

**Water surface elevation at Lake Livingston on sampling day was 131.87.

APPENDIX D

LABORATORY DATA ON WATER, ELUTRIATES, AND BOTTOM SEDIMENTS

TABLE D-1 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 1

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfiltered Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
SOLIDS:							
Total or Dissolved solids, mg/l	530	500	960	560	430	60	<500(1)
Volatile solids, mg/l	110	150	100	64	-10	-86	
Volatile solids, %	22	31	11	11	-11	-20	
NITROGEN:							
Ammonia Nitrogen, mg/l	6.9	5.8	10.9	10.0	4.0	4.2	0.016(2)
Organic Nitrogen, mg/l	2.7	1.5	2.8	1.4	0.1	-0.1	
Total Kjeldahl nitrogen, mg/l	9.6	7.3	13.7	11.4	4.1	4.1	
TOTAL PHOSPHORUS, mg/l	4.3	3.5	1.2	0.8	-3.1	-2.7	
CARBON:							
Total Organic carbon, mg/l	35	27	38	35	3	8	
Total Inorganic carbon, mg/l	43	35	35	38	-8	3	
Total carbon, mg/l	78	62	73	73	-5	11	
HEAVY METALS, µg/l							
Arsenic	<1.5	<1.5	<1.5	<1.5	-	-	50(3)
Cadmium *	3.9	8.6	2.7	11.1	-1.2	2.5	10(3)
Chromium	10.0	10.0	<1.5	<1.5	-	-	50(2)
Copper *	15.0	16.0	8.0	15.0	-7.0	-1.0	1000(3)
Lead *	7.0	2.0	2.0	3.0	-5.0	1.0	50(3)
Manganese *	132.0	198.0	119.0	931.0	-13.0	733.0	50(3)
Mercury	0.6	0.6	0.7	0.6	0.1	0.0	2(2)
Nickel	180.0	<7.0	10.0	<7.0	-170.0	-	
Zinc *	20.0	10.0	20.0	30.0	0.0	20.0	5000(2)
HALOGENATED HYDROCARBONS, µg/l							
Chlordane	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
DDT	<0.5	<0.5	<0.5	<0.5	-	-	1.0(4)
Dieldrin	13.0	0.9	<0.3	<0.3	-	-	1.0(4)
Endrin	<0.3	<0.3	<0.3	<0.3	-	-	0.2(4)
Heptachlor *	25.2	169.0	<0.3	<0.3	-	-	0.1(4)
Lindane *	140.0	302.0	584.0	169.0	-	-	4.0(4)
PCB	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh water chronic toxicity limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-2 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO. 1

TEST PERFORMED		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:	Total dry solids, % wet wt.	74	
	Total dry solids, mg/kg wet wt.	740,000	
	Moisture, % wet wt.	26	
	Volatile solids, % wet wt.	1.0	
	Volatile solids, mg/kg wet wt.	10,400	
	Volatile solids, % dry wt.	1.4	
	Volatile solids, mg/kg dry wt.	14,000	80,000
	Specific gravity wet sediments	1.9	
	Specific gravity dry solids	2.8	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	28	
	Organic nitrogen	220	
	Total Kjeldahl nitrogen	248	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		660	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		8,140	50,000
CARBON: mg/kg dry wt.			
	Total Organic carbon	4,160	
	Total inorganic carbon	5,040	
	Total carbon	9,200	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	1.7	5
	Cadmium	0.6	2
	Chromium	14.0	100
	Copper	6.0	50
	Lead	18.0	50
	Manganese	249.0	
	Mercury	0.2	1
	Nickel	61.0	50
	Zinc	29.0	75
HALOGENATED HYDROCARBONS, mg/kg, dry wt.			
	Chlordane	2.2	
	DDT	3.3	
	Dieldrin	<0.3	
	Endrin	0.9	
	Heptachlor	M*	
	Lindane	M*	
PCB		<0.01	
[illegible], mg/kg, dry wt.		380	
[illegible], mg/kg, dry wt.		420	
IMMEDIATE OXYGEN DEMAND, mg/l		1.8	

*Results masked by interfering substances.

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-3 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 2

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
[illegible] solids, mg/l	570	570	890	570	320	0.0	<500(1)
[illegible], ml/l	110	130	175	79	65	-51	
[illegible], %	20	24	20	14	0.0	-10	
[illegible], mg/l	6.1	6.0	18.9	19.0	12.8	13.0	0.016(2)
[illegible], mg/l	3.0	1.5	2.8	2.0	-0.2	0.5	
[illegible], mg/l	9.1	7.5	21.7	21.0	12.6	13.5	
[illegible], mg/l	5.3	5.0	5.1	2.4	-0.2	-2.6	
[illegible], mg/l	32	29	53	32	21	3	
[illegible], mg/l	31	33	38	30	7	-3	
[illegible], mg/l	63	62	91	62	28	0.0	
[illegible], mg/l	<1.5	<1.5	<1.5	<1.5	-	-	50(3)
[illegible] *	5.7	8.4	3.9	11.8	-1.8	3.4	10(3)
[illegible]	10.0	10.0	5.0	5.0	-5.0	-5.0	50(2)
[illegible] *	34.0	42.0	30.0	15.0	-4.0	-27.0	1000(3)
[illegible]	2.0	2.0	4.0	1.0	2.0	-1.0	50(3)
[illegible] *	112.0	165.0	317.0	1003.0	205.0	838.0	50(3)
[illegible]	0.6	0.3	0.3	0.3	-0.3	0.0	2(2)
[illegible] *	26.0	<7.0	<7.0	12.0	-	-	
[illegible] *	40.0	50.0	10.0	<0.05	-30.0	-	5000(2)
[illegible], mg/l	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
[illegible] *	<0.5	<0.5	<0.5	<0.5	-	-	1.0(4)
[illegible]	58.0	0.3	136.0	<0.3	78.0	-	1.0(4)
[illegible]	<0.3	<0.3	<0.3	<0.3	-	-	0.2(4)
[illegible]	<0.3	<0.3	9.2	6.2	-	-	0.1(4)
[illegible] *	133.0	83.0	26.0	28.0	-	-	4.0(4)
[illegible]	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh water chronic toxicity limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-4 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO. 2

PARAMETER	CONCENTRATION	EPA CRITERIA[1]
SOLIDS: Total dry solids, % wet wt.	53	
Total dry solids, mg/kg wet wt.	527,000	
Moisture, % wet wt.	47	
Volatile solids, % wet wt.	2.4	
Volatile solids, mg/kg wet wt.	24,000	
Volatile solids, % dry wt.	4.6	
Volatile solids, mg/kg dry wt.	45,600	80,000
Specific gravity wet sediments	1.4	
Specific gravity dry solids	2.2	
NITROGEN: mg/kg dry wt.		
Ammonia nitrogen	200	
Organic nitrogen	1,250	
Total Kjeldanl nitrogen	1,450	1000
TOTAL PHOSPHORUS, mg/kg dry wt.	1,440	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.	20,900	50,000
CARBON: mg/kg dry wt.		
Total Organic carbon	14,300	
Total inorganic carbon	10,900	
Total carbon	25,200	
HEAVY METALS, mg/kg, dry wt.		
Arsenic	3.3	5
Cadmium	13.4	2
Chromium	37.0	100
Copper	16.5	50
Lead	57.0	50
Manganese	372.0	
Mercury	0.4	1
Nickel	6.7	50
Zinc	115.0	75
CHLORINATED HYDROCARBONS, ug/kg, dry wt.		
Chlordane	6.0	
[illegible]	30.0	
[illegible]	18.0	
Endrin	7.0	
[illegible]	M*	
[illegible]	M*	
[illegible]	<0.01	
[illegible], dry wt.	1,340	
[illegible], mg/kg, dry wt.	830	
[illegible], mg/l	7.1	

*Results masked by interfering substances.

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-5 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 3

[illegible] formed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
[illegible] solids, mg/l	570	560	970	630	400	70	<500(1)
[illegible], mg/l	84	91	150	75	66	-16	
[illegible], %	15	16	15	12	0.0	-4	
[illegible] nitrogen, mg/l	6.5	6.3	6.5	4.5	0.0	-1.8	0.016(2)
[illegible], mg/l	1.1	1.1	2.0	1.0	0.9	-0.1	
[illegible] nitrogen, mg/l	7.6	7.4	8.5	5.5	0.9	-1.9	
[illegible], mg/l	6.2	6.0	4.0	3.1	-2.2	-2.9	
[illegible] carbon, mg/l	28	28	45	20	17	-8	
[illegible] carbon, mg/l	35	33	38	38	3	5	
[illegible] mg/l	63	61	83	58	20	-3	
[illegible], ug/l							
	<1.5	<1.5	<1.5	<1.5	-	-	50(3)
*	3.6	5.0	3.6	1.8	0.0	-3.2	10(3)
*	5.0	10.0	10.0	<1.5	5.0	-	50(2)
	17.0	12.0	10.0	5.0	-7.0	-7.0	1000(3)
	<1.0	<1.0	1.5	1.5	-	-	50(3)
*	152.0	158.0	211.0	858.0	59.0	700.0	50(3)
*	0.3	0.2	0.3	0.4	0.0	0.2	2(2)
*	57.0	82.0	<7.0	10.0	-	-72.0	
	10.0	<0.05	70.0	<0.05	60.0	-	5000(2)
[illegible] CARBON, mg/l							
	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
	<0.5	<0.5	<0.5	<0.5	-	-	1.0(4)
	<0.3	<0.3	193.0	M**	-	-	1.0(4)
	15.0	<0.3	<0.3	<0.3	-	-	0.2(4)
[illegible]	<0.3	<0.3	299.0	<0.3	-	-	0.1(4)
	35.5	7.8	40.0	21.3	4.5	13.5	4.0(4)
	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

**Results masked by interfering substances. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh Water Chronic Toxicity Limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-6 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO. 3

TEST PARAMETER		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:	Total dry solids, % wet wt.	73	
	Total dry solids, mg/kg wet wt.	729,400	
	Moisture, % wet wt.	27	
	Volatile solids, % wet wt.	0.7	
	Volatile solids, mg/kg wet wt.	7,190	
	Volatile solids, % dry wt.	1.0	
	Volatile solids, mg/kg dry wt.	9,850	80,000
	Specific gravity wet sediments	1.8	
	Specific gravity dry solids	2.6	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	3	
	Organic nitrogen	190	
	Total Kjeldahl nitrogen	193	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		330	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		4,200	50,000
CARBON: mg/kg dry wt.			
	Total organic carbon	3,270	
	Total inorganic carbon	3,920	
	Total carbon	7,190	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	1.6	5
	Cadmium	0.7	2
	Chromium	18.0	100
	Copper	5.5	50
	Lead	24.0	50
	Manganese	181.0	
	Mercury	0.2	1
	Nickel	54.0	50
	Zinc	27.0	75
HALOGENATED HYDROCARBONS, µg/kg, dry wt.			
	Chlordane	< 0.3	
	DDT	2.9	
	Dieldrin	0.3	
	Endrin	4.7	
	Heptachlor	4.9	
	PCB	0.4	
PAH		<0.01	
[illegible], mg/kg, dry wt.		1,120	
[illegible], mg/kg, dry wt.		620	
[illegible], mg/kg		0.8	

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-7 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 4

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
SOLIDS:							
Total or Dissolved solids, mg/l	610	610	1830	610	1220	0.0	<500(1)
Volatile solids, mg/l	110	99	390	190	280	91	
Volatile solids, %	18	16	21	32	3	16	
NITROGEN:							
Ammonia Nitrogen, mg/l	9.9	9.1	10.6	10.2	0.7	1.1	0.016(2)
Nitrate Nitrogen, mg/l	3.8	1.4	6.9	1.5	3.1	0.1	
Total Kjeldahl nitrogen, mg/l	13.7	10.5	17.5	11.7	3.8	1.2	
Organic Nitrogen, mg/l	7.2	6.1	8.8	4.6	1.6	-1.5	
CARBON:							
Total Organic carbon, mg/l	34	28	51	30	17	2	
Total Inorganic carbon, mg/l	41	48	51	50	10	2	
Total carbon, mg/l	75	76	102	80	27	4	
HEAVY METALS, ug/l							
Arsenic	4.0	<1.5	1.8	<1.5	-2.2	-	50(3)
Chromium	13.5	2.1	16.4	3.9	2.9	1.8	1(3)
Copper	2500.0	10.0	620.0	5.0	-1880.0	-5.0	5(3)
Iron	720.0	20.0	400.0	19.0	-320.0	-1.0	1000(3)
Lead	1419.0	2.0	907.0	2.0	-512.0	0.0	50(3)
Manganese	950.0	158.0	2500.0	79.0	1550.0	-79.0	50(3)
Mercury	0.5	0.3	0.3	0.1	-0.2	-0.2	2(2)
Nickel	20,800.0	300.0	245.0	<7.0	-20,555.0	-	
Zinc	176.0	30.0	309.0	<0.05	133.0	-	5000(2)
CHLORINATED HYDROCARBONS, ug/l							
Endrin	0.3	0.3	<0.3	<0.3	-	-	0.2(4)
Lindane	7.0	4.5	34.8	7.5	27.8	3.0	4(4)
Methoxychlor	1.7	0.3	8.7	0.6	7.0	-	100(4)
Toxaphene*	34.5	23.5	33.5	38.5	-1.0	15.0	0.5(4)
2,4-D, Dichlor	5.4	3.5	M**	11.1	-	7.6	0.1(4)
2,4,5-TP Silvex	10.4	10.1	12.5	4.1	2.1	-6.0	4.0(4)
PCB	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

**Results masked by interfering substances. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh Water Chronic Toxicity Limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-8 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO 4

[illegible]		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:	Total dry solids, % wet wt.	37	
	Total dry solids, mg/kg wet wt.	367,000	
	Moisture, % wet wt.	63	
	Volatile solids, % wet wt.	4.1	
	Volatile solids, mg/kg wet wt.	40,800	
	Volatile solids, % dry wt.	11.1	
	Volatile solids, mg/kg dry wt.	111,000	80,000
	Specific gravity wet sediments	1.2	
	Specific gravity dry solids	1.8	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	121	
	Organic nitrogen	2,220	
	Total Kjeldahl nitrogen	2,341	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		3,850	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		61,800	50,000
CARBON: mg/kg dry wt.			
	Total Organic carbon	28,790	
	Total inorganic carbon	8,780	
	Total carbon	37,570	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	4.4	5
	Cadmium	15.3	2
	Chromium	120.0	100
	Copper	73.5	50
	Lead	69.5	50
	Manganese	372.0	
	Mercury	0.4	1
	Nickel	18.0	50
	Zinc	136.0	75
HALOGENATED HYDROCARBONS, µg/kg, dry wt.			
	Chlordane	45.0	
	DDT	53.6	
	Dieldrin	0.3	
	Endrin	19.0	
	Heptachlor	M*	
	Lindane	M*	
PCB		<0.01	
[illegible] A.B.S., mg/kg, dry wt.		7,350	
[illegible] mg/kg, dry wt.		1,470	
[illegible] DEMAND, mg/l		3.6	

*Results masked by interfering substances.

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-9 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 5

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
[illegible]							
[illegible] or dissolved solids, mg/l	660	550	1380	850	720	300	<500(1)
Volatile solids, mg/l	180	96	370	240	190	144	
Volatile solids, %	27	17	27	28	0	11	
[illegible]							
Ammonia Nitrogen, mg/l	9.1	8.7	43.0	41.8	33.9	33.1	0.016(2)
Organic Nitrogen, mg/l	4.0	2.7	9.5	2.6	5.5	-0.1	
Total Kjeldahl nitrogen, mg/l	13.1	11.4	52.5	44.4	39.4	33.0	
[illegible] PHOSPHORUS, mg/l	5.6	4.6	2.7	1.4	-2.9	-3.2	
[illegible]							
Total organic carbon, mg/l	45	17	60	48	15	31	
Total Inorganic carbon, mg/l	33	33	85	63	52	30	
Total carbon, mg/l	78	50	145	111	67	61	
[illegible] METALS, ug/l							
[illegible]	6.0	<1.5	1.6	<1.5	-4.4	-	50(3)
[illegible]	19.5	1.8	15.0	5.4	-4.5	3.6	10(3)
[illegible]	1150.0	<1.5	1000.0	<1.5	-150.0	-	50(2)
[illegible]	200.0	<2.0	460.0	5.0	260.0	-	1000(3)
[illegible]	165.0	3.0	434.0	3.0	269.0	0.0	50(3)
[illegible]*	137.0	158.0	950.0	152.0	813.0	-6.0	50(3)
[illegible]*	0.3	0.3	0.3	0.6	0.0	0.3	2(2)
[illegible]	605.0	<7.0	310.0	57.0	-295.0	-	
[illegible]	215.0	30.0	160.0	30.0	- 55.0	0.0	5000(2)
[illegible] CHLORINATED HYDROCARBONS, ug/l							
[illegible]ne	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
DDT*	3.2	3.2	4.7	6.4	1.5	3.2	1.0(4)
[illegible]drin	3.1	0.5	3.1	1.0	0.0	0.5	1.0(4)
[illegible]rin	16.2	1.0	15.2	13.2	-1.0	12.2	0.2(4)
Heptachlor*	2.1	2.5	9.8	6.8	7.7	4.3	0.1(4)
Lindane*	6.6	9.6	M**	1.8	-	-7.8	4.0(4)
[illegible]	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

**Results masked by interfering substances. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh Water Chronic Toxicity Limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-10 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO.5

TEST PERFORMED		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:	Total dry solids, % wet wt.	45	
	Total dry solids, mg/kg wet wt.	446,000	
	Moisture, % wet wt.	55	
	Volatile solids, % wet wt.	5.4	
	Volatile solids, mg/kg wet wt.	54,000	
	Volatile solids, % dry wt.	12.1	
	Volatile solids, mg/kg dry wt.	121,000	80,000
	Specific gravity wet sediments	1.4	
	Specific gravity dry solids	2.8	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	660	
	Organic nitrogen	2,980	
	Total Kjeldahl nitrogen	3,640	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		2,170	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		76,520	50,000
CARBON: mg/kg dry wt.			
	Total Organic carbon	26,230	
	Total inorganic carbon	6,700	
	Total carbon	32,930	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	4.6	5
	Cadmium	18.1	2
	Chromium	110.1	100
	Copper	88.7	50
	Lead	66.5	50
	Manganese	425.0	
	Mercury	0.3	1
	Nickel	21.0	50
	Zinc	188.0	75
HALOGENATED HYDROCARBONS, µg/kg, dry wt.			
	Chlordane	47.4	
	DDT	41.8	
	Dieldrin	33.0	
	Endrin	17.0	
	Heptachlor	M*	
	Lindane	M*	
PCB		<0.01	
OIL AND GREASE, mg/kg, dry wt.		8,340	
NON-VOLATILE SOLIDS, mg/kg, dry wt.		1,670	
IMMEDIATE OXYGEN DEMAND, mg/ℓ		7.5	

*Results masked by interfering substances.

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-11 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 6

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
SOLIDS:							
Total or Dissolved solids, mg/l	640	630	2630	730	1990	100	<500(1)
Volatile solids, mg/l	90	75	730	220	640	145	
Volatile solids, %	14	12	28	30	14	18	
NITROGEN:							
Ammonia Nitrogen, mg/l	8.8	8.5	43.3	43.1	34.5	34.6	0.016(2)
Organic Nitrogen, mg/l	2.1	1.6	21.0	2.4	18.9	0.8	
Total Kjeldahl nitrogen, mg/l	10.9	10.1	64.3	45.5	53.4	35.4	
TOTAL PHOSPHORUS, mg/l	3.7	2.9	11.4	3.2	7.7	0.3	
CARBON:							
Total Organic carbon, mg/l	16	12	150	22	134	10	
Total Inorganic carbon, mg/l	54	53	120	105	66	52	
Total carbon, mg/l	70	65	270	127	200	62	
HEAVY METALS, µg/l							
Arsenic	4.0	<1.5	46.0	<1.5	42.0	-	50(3)
Cadmium	9.4	2.1	20.8	0.7	11.4	-1.4	10(3)
Chromium	1050.0	<1.5	750.0	20.0	-300.0	-	50(2)
Copper	140.0	35.0	1620.0	40.0	1480.0	5.0	1000(3)
Lead	104.0	<1.0	1215.0	9.0	1111.0	-	50(3)
Manganese*	80.0	152.0	1250.0	667.0	1170.0	515.0	50(3)
Mercury	0.2	0.2	0.2	0.2	0.0	0.0	2(2)
Nickel	4550.0	28.0	440.0	<7.0	-4110.0	-	
Zinc	115.0	60.0	754.0	60.0	639.0	0.0	5000(2)
HALOGENATED HYDROCARBONS, µg/l							
Chlordane	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
DDT	2.1	2.1	16.5	4.1	14.4	2.0	1.0(4)
Dieldrin	7.2	4.3	70.7	7.2	63.5	2.9	1.0(4)
Endrin	6.9	6.9	19.3	15.2	12.4	8.3	0.2(4)
Heptachlor	1.1	1.1	M**	3.4	-	2.3	0.1(4)
Lindane*	13.6	16.4	M**	6.2	-	-10.2	4.0(4)
PCB	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.
**Results masked by interfering substances. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.
(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.
(3) Fresh Water Chronic Toxicity Limit, "Quality Criteria for Water," EPA 1976.
(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-12 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO. 6

TEST PERFORMED		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:			
	Total dry solids, % wet wt.	31	
	Total dry solids, mg/kg wet wt.	311,000	
	Moisture, % wet wt.	69	
	Volatile solids, % wet wt.	4.9	
	Volatile solids, mg/kg wet wt.	48,900	
	Volatile solids, % dry wt.	15.7	
	Volatile solids, mg/kg dry wt.	157,000	80,000
	Specific gravity wet sediments	1.2	
	Specific gravity dry solids	2.2	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	860	
	Organic nitrogen	3,530	
	Total Kjeldahl nitrogen	4,390	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		5,660	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		110,000	50,000
CARBON: mg/kg dry wt.			
	Total Organic carbon	46,500	
	Total inorganic carbon	6,890	
	Total carbon	53,390	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	4.8	5
	Cadmium	17.5	2
	Chromium	120.0	100
	Copper	159.0	50
	Lead	82.5	50
	Manganese	489.0	
	Mercury	0.4	1
	Nickel	15.0	50
	Zinc	241.0	75
HALOGENATED HYDROCARBONS, µg/kg, dry wt.			
	Chlordane	64.0	
	DDT	39.7	
	Dieldrin	80.0	
	Endrin	20.0	
	Heptachlor	M*	
	Lindane	M*	
PCB		<0.01	
OIL AND GREASE, mg/kg, dry wt.		2,550	
NON-SETTLEABLE SOLIDS, mg/kg, dry wt.		8,560	
IMMEDIATE OXYGEN DEMAND, mg/ℓ		4.9	

*Results masked by interfering substances.

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-13 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 7

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
SOLIDS:							
Total or Dissolved solids, mg/l	530	440	1230	500	700	60	<500(1)
Volatile solids, mg/l	34	43	170	91	136	48	
Volatile solids, %	6	97	14	18	8	-79	
NITROGEN:							
Ammonia Nitrogen, mg/l	5.1	4.6	1.8	1.2	-3.3	-3.4	0.016(2)
Organic Nitrogen, mg/l	2.8	1.2	3.0	1.0	0.2	-0.2	
Total Kjeldahl nitrogen, mg/l	7.9	5.8	4.8	2.2	-3.1	-3.6	
TOTAL PHOSPHORUS, mg/l	4.0	2.9	1.4	0.7	-2.6	-2.2	
CARBON:							
Total Organic carbon, mg/l	42	17	40	30	-2	13	
Total Inorganic carbon, mg/l	43	43	45	43	2	0	
Total carbon, mg/l	85	60	85	73	0	13	
HEAVY METALS, µg/l							
Arsenic	12.0	<1.5	13.0	<1.5	1.0	-	50(3)
Cadmium	11.4	3.5	10.4	6.5	-1.0	3.0	10(3)
Chromium	450.0	10.0	1375.0	<1.5	925.0	-	50(2)
Copper	700.0	23.0	300.0	6.0	-400.0	-17.0	1000(3)
Lead	308.0	<1.0	119.0	6.9	-189.0	-	50(3)
Manganese	115.0	80.0	1312.0	640.0	1197.0	560.0	50(3)
Mercury	0.4	<0.05	0.4	<0.05	0.0	-	2(2)
Nickel	105.0	<7.0	565.0	10.0	460.0	-	
Zinc	188.0	<0.05	535.0	10.0	347.0	-	5000(2)
HALOGENATED HYDROCARBONS, µg/l							
Chlordane	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
DDT	9.2	4.9	12.3	9.8	3.1	4.9	1.0(4)
Dieldrin*	9.7	42.2	47.2	26.7	37.5	-15.5	1.0(4)
Endrin*	5.1	4.3	5.4	6.5	0.3	2.2	0.2(4)
Heptachlor	4.7	4.6	16.9	14.1	12.2	9.5	0.1(4)
Lindane	13.0	9.9	17.4	14.6	4.4	4.7	4.0(4)
PCB	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh water chronic toxicity limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-14 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO.7

TEST PERFORMED		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:	Total dry solids, % wet wt.	39	
	Total dry solids, mg/kg wet wt.	856,000	
	Moisture, % wet wt.	61	
	Volatile solids, % wet wt.	2.9	
	Volatile solids, mg/kg wet wt.	29,200	
	Volatile solids, % dry wt.	7.6	
	Volatile solids, mg/kg dry wt.	75,700	80,000
	Specific gravity wet sediments	1.3	
	Specific gravity dry solids	2.5	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	56	
	Organic nitrogen	810	
	Total Kjeldahl nitrogen	866	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		340	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		24,700	50,000
CARBON: mg/kg dry wt.			
	Total Organic carbon	11,000	
	Total inorganic carbon	8,160	
	Total carbon	19,160	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	1.3	5
	Cadmium	4.2	2
	Chromium	9.8	100
	Copper	9.0	50
	Lead	17.5	50
	Manganese	55.0	
	Mercury	2.2	1
	Nickel	60.0	50
	Zinc	34.0	75
HALOGENATED HYDROCARBONS, µg/kg, dry wt.			
	Chlordane	4.4	
	DDT	9.8	
	Dieldrin	176	
	Endrin	3.0	
	Heptachlor	M*	
	Lindane	M*	
PCB		<0.01	
OIL AND GREASE, mg/kg, dry wt.		730	
NON-SETTLEABLE SOLIDS, mg/kg, dry wt.		710	
IMMEDIATE OXYGEN DEMAND, mg/ℓ		5.3	

*Results masked by interfering substances.

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-15 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 8

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
SOLIDS:							
Total or Dissolved solids, mg/l	430	380	1650	720	1220	340	<500(1)
Volatile solids, mg/l	110	73	340	160	230	87	
Volatile solids, %	26	19	21	22	-5	3	
NITROGEN:							
Ammonia Nitrogen, mg/l	8.6	6.5	3.7	3.0	-4.9	-3.5	0.016(2)
Organic Nitrogen, mg/l	1.5	1.3	2.8	1.3	1.3	0.0	
Total Kjeldahl nitrogen, mg/l	10.1	7.8	6.5	4.3	-3.6	-3.5	
TOTAL PHOSPHORUS, mg/l	3.9	3.7	1.9	0.3	-2.0	-3.4	
CARBON:							
Total Organic carbon, mg/l	26	23	15	23	-11	0	
Total Inorganic carbon, mg/l	47	44	78	43	31	-1	
Total carbon, mg/l	73	67	93	66	20	-1	
HEAVY METALS, µg/l							
Arsenic	6.0	<1.5	13.0	<1.5	7.0	-	50(3)
Cadmium	8.7	2.5	9.7	<0.1	1.0	-	10(3)
Chromium	737.0	<1.5	250.0	10.0	-487.0	-	50(2)
Copper	260.0	5.0	440.0	39.0	180.0	34.0	1000(3)
Lead	445.0	2.0	284.0	2.0	-161.0	0.0	50(3)
Manganese*	125.0	172.0	1375.0	779.0	1250.0	607.0	50(3)
Mercury*	0.3	0.4	0.3	0.3	0.0	-0.1	2(2)
Nickel	190.0	10.0	55.0	42.0	-135.0	32.0	
Zinc*	57.0	80.0	195.0	20.0	138.0	-60.0	5000(2)
CHLORINATED HYDROCARBONS, µg/l							
Chlordane	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
DDT	4.4	3.5	11.7	3.5	7.3	0.0	1.0(4)
Dieldrin	9.4	3.2	8.1	3.2	-1.3	0.0	1.0(4)
Endrin	9.2	1.1	82.0	1.0	72.8	-0.1	0.2(4)
Heptachlor	30.4	5.0	92.4	1.6	62.0	-3.4	0.1(4)
Lindane*	17.1	11.6	7.3	14.6	-9.8	3.0	4.0(4)
PCB	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh water chronic toxicity limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-16 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO.8

TEST PERFORMED		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:	Total dry solids, % wet wt.	71	
	Total dry solids, mg/kg wet wt.	706,000	
	Moisture, % wet wt.	30	
	Volatile solids, % wet wt.	2.9	
	Volatile solids, mg/kg wet wt.	29,200	
	Volatile solids, % dry wt.	4.1	
	Volatile solids, mg/kg dry wt.	41,400	80,000
	Specific gravity wet sediments	1.7	
	Specific gravity dry solids	2.4	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	53	
	Organic nitrogen	430	
	Total Kjeldahl nitrogen	483	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		55	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		9,450	50,000
CARBON: mg/kg dry wt.			
	Total Organic carbon	5,440	
	Total inorganic carbon	3,120	
	Total carbon	8,560	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	2.4	5
	Cadmium	0.7	2
	Chromium	12.0	100
	Copper	9.8	50
	Lead	18.0	50
	Manganese	315.0	
	Mercury	.3	1
	Nickel	16.0	50
	Zinc	29.0	75
HALOGENATED HYDROCARBONS, µg/kg, dry wt.			
	Chlordane	<0.3	
	DDT	19.9	
	Dieldrin	13.6	
	Endrin	15.4	
	Heptachlor	M*	
	Lindane	M*	
PCB		< 0.01	
OIL AND GREASE, mg/kg, dry wt.		440	
NON-VOLATILE SOLIDS, mg/kg, dry wt.		2,650	
IMMEDIATE OXYGEN DEMAND, mg/l		1.8	

*Results masked by interfering substances.

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-17 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 9

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
SOLIDS:							
Total or Dissolved solids, mg/l	560	510	1290	370	730	-140	500(1)
Volatile solids, mg/l	230	220	290	130	60	-90	
Volatile solids, %	41	43	22	34	-19	-9	
NITROGEN:							
Ammonia Nitrogen, mg/l	2.30	1.30	0.10	0.03	-2.20	-1.27	0.016(2)
Organic Nitrogen, mg/l	1.20	0.90	2.50	0.74	1.30	-0.16	
Total Kjeldahl nitrogen, mg/l	3.50	2.20	2.60	0.77	-0.90	-1.43	
TOTAL PHOSPHORUS, mg/l	1.8	1.6	1.3	0.2	-0.5	-1.4	
CARBON:							
Total Organic carbon, mg/l	20	17	26	18	6	1	
Total Inorganic carbon, mg/l	41	40	50	42	9	2	
Total carbon, mg/l	61	57	76	60	15	3	
HEAVY METALS, µg/l							
Arsenic	6.0	<1.5	21.0	<1.5	15.0	-	50(3)
Cadmium*	7.4	<0.1	9.0	11.0	1.6	-	[illegible](3)
Chromium	562.0	<1.5	437.0	<1.5	-125.0	-	[illegible](2)
Lead*	220.0	<2.0	400.0	<2.0	180.0	-	[illegible](3)
Nickel	522.0	2.0	192.0	1.5	-330.0	-0.5	[illegible](3)
Manganese	137.0	79.0	2500.0	581.0	2363.0	502.0	[illegible](3)
Mercury	0.2	0.2	0.4	0.3	0.2	0.1	[illegible](2)
Silver	70.0	7.0	95.0	<7.0	25.0	-	
Zinc	61.0	10.0	157.0	<0.05	96.0	-	500(2)
HALOGENATED HYDROCARBONS, µg/l							
Chlordane	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
DDT	12.8	1.1	6.3	1.3	-6.5	0.2	[illegible](4)
Endrin	152.9	6.1	31.9	5.3	-121.0	-0.8	[illegible](4)
Dieldrin	326.7	4.5	10.5	0.4	-316.2	-4.1	[illegible](4)
Light Halogens	9.5	1.9	48.3	2.2	38.8	0.3	[illegible](4)
Lindane*	4.6	13.8	8.7	8.0	4.1	-5.8	4.0(4)
PCB	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh water chronic toxicity limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-18 LABORATORY DATA - BOTTOM SEDIMENTS, SAMPLING SITE NO. 9

[illegible]	[illegible]	EPA STANDARDS[1]
SOLIDS:		
Total dry solids, % wet wt.	46	
Total dry solids, mg/kg wet wt.	163,000	
Moisture, % wet wt.	54	
Volatile solids, % wet wt.	3.2	
Volatile solids, mg/kg wet wt.	31,600	
Volatile solids, % dry wt.	6.8	
Volatile solids, mg/kg dry wt.	68,300	80,000
Specific gravity wet sediments	1.4	
Specific gravity dry solids	2.6	
NITROGEN: mg/kg dry wt.		
Ammonia nitrogen	14	
Organic nitrogen	770	
Total Kjeldahl nitrogen	784	1000
TOTAL PHOSPHORUS, mg/kg dry wt.	37	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.	21,900	50,000
CARBON: mg/kg dry wt.		
Total Organic carbon	9,900	
Total inorganic carbon	4,170	
Total carbon	14,070	
HEAVY METALS, mg/kg, dry wt.		
Arsenic	3.6	5
Cadmium	14.1	2
Chromium	10.0	100
Copper	49.3	50
Lead	74.5	50
Manganese	305.0	
Mercury	0.3	1
Nickel	11.0	50
Zinc	128.0	75
[illegible]		
[illegible]	0.3	
[illegible]	2.9	
[illegible]	5.0	
[illegible]	6.3	
[illegible]	4.3	
[illegible]	0.7	
[illegible]	0.01	
[illegible]	1,780	
[illegible]	430	
[illegible]	1.7	

[1]Proposed Standards for Region VI, EPA 1973.

	615	480	1810	460	1200	-20	500(1)
	143	160	350	140	207	-20	
	29	33	19	31	-4	-2	
	2.8	2.7	1.1	0.7	-1.7	-2.0	0.016(2)
	1.4	1.2	3.5	0.8	2.1	-0.4	
	4.2	3.9	4.6	1.5	0.4	-2.4	
	2.0	2.0	0.4	0.4	-1.6	-1.6	
	24	21	40	17	16	-4	
	35	35	43	36	8	1	
	59	56	83	53	24	-3	
	6.0	1.5	21.0	1.5	15.0	-	50(3)
	9.4	2.5	10.3	0.5	0.8	-2.0	10(3)
	812.0	1.5	550.0	1.5	-262.0	-	50(2)
	600.0	3.0	620.0	3.0	20.0	0.0	1000(3)
	110.0	8.1	225.0	1.5	115.0	-6.6	50(3)
	125.0	30.0	1475.0	320.0	1350.0	290.0	50(3)
	0.4	0.05	0.4	0.05	0.0	-	2(2)
	60.0	7.0	10140.0	7.0	10,080.0	-	
	172.0	30.0	255.0	0.05	83.0	-	5000(2)
	0.3	0.3	0.3	0.3	-	-	3.0(4)
	2.5	1.1	2.2	1.1	-0.3	0.0	1.0(4)
	5.6	3.0	4.4	3.0	-1.2	0.0	1.0(4)
	53.4	37.1	61.8	56.3	8.4	19.2	0.2(4)
	2.6	0.3	**	0.3	-	0.0	0.1(4)
	7.2	8.5	6.4	7.6	-0.8	-0.9	4.0(4)
	0.01	0.01	0.01	0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

**Results masked by interfering substances. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh Water Chronic Toxicity Limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-20 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO. 10

[illegible]		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:	Total dry solids, % wet wt.	39	
	Total dry solids, mg/kg wet wt.	392,000	
	[illegible], % wet wt.	61	
	Volatile solids, % wet wt.	1.7	
	Volatile solids, mg/kg wet wt.	16,800	
	Volatile solids, % dry wt.	4.3	
	Volatile solids, mg/kg dry wt.	43,000	80,000
	Specific gravity wet sediments	1.2	
	Specific gravity dry solids	1.8	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	37	
	Organic nitrogen	560	
	Total Kjeldahl nitrogen	597	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		75	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		15,900	50,000
CARBON: mg/kg dry wt.			
	Total Organic carbon	8,360	
	Total inorganic carbon	2,210	
	Total carbon	10,570	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	1.1	5
	Cadmium	2.2	2
	Chromium	3.0	100
	Copper	32.5	50
	Lead	18.0	50
	Manganese	170.0	
	Mercury	0.5	1
	Nickel	75.0	50
	Zinc	33.0	75
CHLORINATED HYDROCARBONS, µg/kg, dry wt.			
	Chlordane	<0.3	
	DDT	<0.5	
	Dieldrin	<0.3	
	Endrin	<0.3	
	Heptachlor	0.7	
	Lindane	0.2	
PCB		<0.01	
OIL AND GREASE, mg/kg, dry wt.		490	
[illegible]-trichloroethane, mg/kg dry wt.		710	
THEORETICAL OXYGEN DEMAND, mg/		1.9	

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-21 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 11

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
[illegible]							
[illegible] of Dissolved solids, mg/l	410	260	1090	400	680	140	<500(1)
[illegible] solids, mg/l	190	120	240	140	50	20	
[illegible] solids, %	46	46	22	35	-24	-11	
[illegible]							
[illegible] Nitrogen, mg/l	0.7	0.7	1.0	1.0	0.3	0.3	0.016(2)
[illegible] Nitrogen, mg/l	1.2	0.9	1.8	0.8	0.6	-0.1	
[illegible] Kjeldahl nitrogen, mg/l	1.9	1.6	2.8	1.8	0.9	0.2	
[illegible], mg/l	1.0	0.6	1.3	0.1	0.3	-0.5	
[illegible] carbon, mg/l	17	11	22	12	5	1	
[illegible] carbon, mg/l	28	29	33	31	5	2	
[illegible], mg/l	45	40	55	43	10	3	
[illegible], mg/l							
[illegible]	5.0	<1.5	20.0	<1.5	15.0	-	50(3)
[illegible]	9.4	<0.1	3.8	0.7	-5.6	-	10(3)
[illegible]	825.0	<1.5	337.0	<1.5	-488.0	-	50(2)
[illegible]	240.0	4.0	140.0	<2.0	-100.0	-	1000(3)
[illegible]	11,490.0	<1.0	126.0	5.5	-11,364.0	-	50(3)
[illegible]	217.0	79.0	1212.0	844.0	995.0	765.0	50(3)
[illegible]	0.1	0.1	0.2	0.2	0.1	0.1	2(2)
[illegible]	760.0	10.0	130.0	<7.0	-630.0	-	
[illegible]	95.0	40.0	111.0	40.0	16.0	0.0	5000(2)
[illegible] HYDROCARBONS, µg/l							
[illegible]	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
[illegible]	1.4	<0.5	5.7	4.8	4.3	-	1.5(4)
[illegible]	233.5	<0.3	65.5	5.5	-168.0	-	1.0(4)
[illegible]	30.5	0.8	69.0	5.1	38.5	4.3	0.2(4)
[illegible]	46.5	5.9	31.6	5.1	-14.9	-0.8	0.1(4)
[illegible]	5.2	1.1	5.4	3.7	0.2	2.6	4.0(4)
[illegible]	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh water chronic toxicity limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-22 LABORATORY DATA - BOTTOM SEDIMENTS, SAMPLING SITE NO. 11

[illegible]	CONCENTRATION	EPA CRITERIA[1]
SOLIDS:		
Total dry solids, % wet wt.	57	
Total dry solids, mg/kg wet wt.	569,000	
Moisture, % wet wt.	43	
Volatile solids, % wet wt.	1.7	
Volatile solids, mg/kg wet wt.	17,300	
Volatile solids, % dry wt.	3.0	
Volatile solids, mg/kg dry wt.	30,400	80,000
Specific gravity wet sediments	1.5	
Specific gravity dry solids	2.4	
NITROGEN: mg/kg dry wt.		
Ammonia nitrogen	14	
Organic nitrogen	270	
Total Kjeldahl nitrogen	284	1000
TOTAL PHOSPHORUS, mg/kg dry wt.	13	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.	9,780	50,000
CARBON: mg/kg dry wt.		
Total Organic carbon	3,930	
Total inorganic carbon	1,030	
Total carbon	4,960	
HEAVY METALS, mg/kg, dry wt.		
Arsenic	3.9	5
Cadmium	1.3	2
Chromium	50.0	100
Copper	16.0	50
Lead	20.5	50
Manganese	239.0	
Mercury	0.3	1
Nickel	7.5	50
Zinc	36.0	75
HALOGENATED HYDROCARBONS, mg/kg, dry wt.		
Chlordane	0.3	
DDT	5.4	
Dieldrin	4.1	
PCB	7.8	
Toxaphene	9.3	
[illegible]	0.2	
[illegible]	0.01	
[illegible] dry wt.	440	
[illegible], mg/kg, dry wt.	440	
[illegible], mg	2.8	

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-23 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 12

Test performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
Solids:							
Total or Dissolved solids, mg/l	570	110	3110	330	2540	220	<500(1)
Volatile solids, mg/l	120	87	320	79	200	-8	
Volatile solids, %	21	76	10	24	-11	52	
Nitrogen:							
Ammonia Nitrogen, mg/l	0.1	0.1	2.3	1.9	2.2	1.8	0.016(2)
Nitrate Nitrogen, mg/l	1.5	0.6	6.8	0.9	5.3	0.3	
Total Kjeldahl nitrogen, mg/l	1.6	0.7	9.1	2.8	7.5	2.1	
Dissolved TKN, mg/l	0.2	0.1	0.8	0.1	0.6	0.0	
Carbon:							
Total Organic carbon, mg/l	36	18	66	27	30	9	
Total Inorganic carbon, mg/l	18	17	34	28	16	11	
Total carbon, mg/l	54	35	100	55	46	20	
TOTAL METALS, mg/l							
Arsenic	12.0	<1.5	135.0	<1.5	123.0	-	50(3)
Cadmium	4.8	2.5	4.0	0.2	-0.8	-2.3	10(3)
Chromium	275.0	<1.5	337.0	<1.5	62.0	-	50(2)
Copper	160.0	<2.0	560.0	<2.0	400.0	-	1000(3)
Iron	341.0	1.8	445.0	<1.0	104.0	-	50(3)
Mercury	200.0	<0.4	3000.0	1000.0	2800.0	-	50(3)
Nickel	<0.05	<0.05	<0.05	<0.05	-	-	2(2)
Lead	1050.0	<7.0	790.0	<7.0	-260.0	-	
Zinc	148.0	10.0	330.0	<0.05	182.0	-	5000(2)
Total Chlorinated HYDROCARBONS, µg/l							
Endrin	<0.3	0.3	***	<0.3	-	-	3.0(4)
Lindane	8.1	3.8	***	4.3	-	0.5	1.0(4)
Methoxychlor	1.4	1.2	***	0.3	-	-0.9	1.0(4)
Toxaphene*	44.7	100.6	***	21.1	-	-79.5	0.2(4)
2,4-D	135.6	3.1	***	22.4	-	19.3	0.1(4)
2,4,5-TP Silvex	2.0	1.0	***	1.7	-	0.7	4.0(4)
PCB	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

**Results masked by interfering substances. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.

(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.

(3) Fresh Water Chronic Toxicity Limit, "Quality Criteria for Water," EPA 1976.

(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975.

TABLE D-24 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO. 12

TEST PERFORMED	CONCENTRATION	EPA CRITERIA[1]
SOLIDS:		
Total dry solids, % wet wt.	58	
Total dry solids, mg/kg wet wt.	573,100	
Moisture, % wet wt.	43	
Volatile solids, % wet wt.	2.5	
Volatile solids, mg/kg wet wt.	25,100	
Volatile solids, % dry wt.	4.5	
Volatile solids, mg/kg dry wt.	44,500	80,000
Specific gravity wet sediments	1.3	
Specific gravity dry solids	1.7	
NITROGEN: mg/kg dry wt.		
Ammonia nitrogen	42	
Organic nitrogen	950	
Total Kjeldahl nitrogen	992	1000
TOTAL PHOSPHORUS, mg/kg dry wt.	1,070	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.	23,600	50,000
CARBON: mg/kg dry wt.		
Total Organic carbon	10,700	
Total inorganic carbon	2,010	
Total carbon	12,710	
HEAVY METALS, mg/kg, dry wt.		
Arsenic	0.8	5
Cadmium	2.2	2
Chromium	3.0	100
Copper	9.3	50
Lead	51.0	50
Manganese	85.0	
Mercury	0.3	1
Nickel	12.0	50
Zinc	65.0	75
[illegible], mg/kg, dry wt.		
Chlordane	0.3	
DDT	0.5	
Dieldrin	0.3	
Endrin	0.3	
Heptachlor	M*	
[illegible]	M*	
[illegible]	0.01	
OIL AND GREASE, mg/kg, dry wt.	810	
NON-SETTLEABLE SOLIDS, mg/kg, dry wt.	1,620	
IMMEDIATE OXYGEN DEMAND, mg/l	6.4	

*Results masked by interfering substances.

[1]Proposed Standards for Region VI, EPA 1973.

TABLE D-25 LABORATORY DATA -- WATER AND ELUTRIATES, SAMPLING SITE NO. 13

Test Performed	(1) River Water Unfiltered	(2) River Water Filtered	(3) Elutriate Unfiltered	(4) Elutriate Filtered	(5) Increase over Unfilt'd Riv. Water=(3)-(1)	(6) Increase over Filtered Riv. Water=(4)-(2)	(7) Water Quality Criteria
SOLIDS:							
Total or Dissolved solids, mg/l	230	180	3400	170	3170	-10	<500(1)
Volatile solids, mg/l	92	74	340	24	248	-50	
Volatile solids, %	40	42	10	14	-30	-28	
NITROGEN:							
Ammonia Nitrogen, mg/l	0.2	0.1	0.1	<0.1	-0.1	-	0.016(2)
Organic Nitrogen, mg/l	1.3	1.1	2.1	0.9	0.8	-0.2	
Total Kjeldahl nitrogen, mg/l	1.5	1.2	2.2	0.9	0.7	-0.3	
TOTAL PHOSPHORUS, mg/l	0.2	0.1	0.1	0.1	-0.1	0.0	
CARBON:							
Total Organic carbon, mg/l	18	21	40	18	22	-3	
Total Inorganic carbon, mg/l	17	18	20	20	3	2	
Total carbon, mg/l	35	39	60	38	25	-1	
HEAVY METALS, µg/l							
Arsenic	11.0	<1.5	210.0	<1.5	199.0	-	50(3)
Cadmium	1.8	1.0	9.0	0.1	7.2	-0.9	10(3)
Chromium	225.0	8.0	392.0	5.0	167.0	-3.0	50(2)
Copper	200.0	5.0	380.0	6.0	180.0	1.0	1000(3)
Lead	110.0	<1.0	561.0	1.2	451.0	-	50(3)
Manganese	150.0	5.0	1250.0	20.0	1100.0	15.0	50(3)
Mercury	<0.05	<0.05	<0.05	<0.05	-	-	2(2)
Nickel	105.0	<7.0	4290.0	<7.0	4185.0	-	
Zinc	81.0	30.0	446.0	<0.05	365.0	-	5000(2)
HALOGENATED HYDROCARBONS, µg/l							
Chlordane	<0.3	<0.3	<0.3	<0.3	-	-	3.0(4)
DDT	17.7	5.9	10.1	1.2	-7.6	-4.7	1.0(4)
Dieldrin	1.4	0.9	1.6	0.4	0.2	-0.5	1.0(4)
Endrin*	4.0	54.2	53.4	13.6	49.4	-40.6	0.2(4)
Heptachlor	8.5	3.2	111.4	6.7	102.9	3.5	0.1(4)
Lindane	5.8	5.1	3.8	3.8	-2.0	-1.3	4.0(4)
PCB	<0.01	<0.01	<0.01	<0.01	-	-	

*Higher concentrations in filtered samples than unfiltered samples. See discussion.

(1) Permissible Surface Water Criteria for Public Water Supplies, "Report of the Committee on Water Quality Criteria," US Department of the Interior, 1968.
(2) Domestic Water Supply "Quality Criteria for Water," EPA 1976.
(3) Fresh water chronic toxicity limit, "Quality Criteria for Water," EPA 1976.
(4) "Primary Drinking Water Proposed Interim Standards," EPA 1975

TABLE D-26 LABORATORY DATA - BOTTOM SEDIMENT, SAMPLING SITE NO.13

[illegible]		CONCENTRATION	EPA CRITERIA[1]
SOLIDS:	Total dry solids, % wet wt.	29	
	Total dry solids, mg/kg wet wt.	293,000	
	Moisture, % wet wt.	71	
	Volatile solids, % wet wt.	0.4	
	Volatile solids, mg/kg wet wt.	4,330	
	Volatile solids, % dry wt.	1,480	
	Volatile solids, mg/kg dry wt.	14,800	80,000
	Specific gravity wet sediments	1.1	
	Specific gravity dry solids	2.7	
NITROGEN: mg/kg dry wt.			
	Ammonia nitrogen	2	
	Organic nitrogen	350	
	Total Kjeldahl nitrogen	352	1000
TOTAL PHOSPHORUS, mg/kg dry wt.		43	
CHEMICAL OXYGEN DEMAND (COD), mg/kg dry wt.		3,170	50,000
CARBON: mg/kg dry wt.			
	Total Organic carbon	2,370	
	Total inorganic carbon	180	
	Total carbon	2,550	
HEAVY METALS, mg/kg, dry wt.			
	Arsenic	0.6	5
	Cadmium	1.6	2
	Chromium	1.0	100
	Copper	11.1	50
	Lead	32.0	50
	Manganese	10.0	
	Mercury	0.2	1
	Nickel	75.0	50
	Zinc	10.0	75
HALOGENATED HYDROCARBONS, µg/kg, dry wt.			
	Chlordane	<0.3	
	DDT	2.0	
	Dieldrin	0.8	
	Endrin	20.0	
	Heptachlor	7.2	
	Lindane	<0.2	
[illegible]		<0.01	
[illegible] AND LEAD, mg/kg, dry wt.		610	
[illegible]-VOLATILE SOLIDS, mg/kg, dry wt.		4,340	
IMMEDIATE OXYGEN DEMAND, mg/l		0.5	

[1]Proposed Standards for Region VI, EPA 1973.

APPENDIX E

STATIC BIOASSAY DATA

TABLE E-1 STATIC BIOASSAY DATA, SAMPLING SITE NO.1 (Unfed Organisms)

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	100	100	100	100	100
- 24	100	100	100	90	100	90
- 36	10	80	100	70	100	90
- 48	0	80	90	50	100	90
- 60	0	80	90	0	100	90
- 72	0	70	90	0	100	90
- 84	0	70	90	0	100	90
- 96	0	70	90	0	90	90
Physical and Chemical Data						
Ammonia Nitrogen mg/l *						
Initial						
Final						
Dissolved Oxygen mg/l						
Initial	8.7	8.8	8.7	8.6	8.6	8.7
Final	8.4	8.1	8.2	8.8	8.4	8.6
Turbidity; Initial JTU	7	6	21	B	B	B
pH Initial	8.2	8.2	8.1	8.4	8.3	8.3
Specific Conductance, Initial μ mhos	810	800	780	800	790	790

Organisms had grown significantly in 6% centrifuged, 20% centrifuged, and 20% filtered samples.

*Data not available.

B = Blank for turbidity measurement.

TABLE E-2 STATIC BIOASSAY DATA, SAMPLING SITE NO.1 (Organisms were fed)

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate 6%	Elutriate 20%	Control River Water	Elutriate 6%	Elutriate 20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	100	100	100	100	100
- 24	80	100	100	90	100	100
- 36	80	100	100	90	100	100
- 48	80	100	90	90	90	90
- 60	70	100	90	90	90	90
- 72	60	100	90	90	90	90
- 84	60	90	90	90	90	90
- 96	60	90	90	90	90	90
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	3.4*	6.0	6.9*	6.8	**	11.9
Final	5.2	5.9	7.7	5.6	5.8	7.9
Dissolved Oxygen mg/l						
Initial	9.5	9.3	9.5	10.6	9.9	9.8
Final	5.6	5.3	5.5	4.9	5.3	5.1
Turbidity; Initial JTU	5	1	1	B	B	B
pH Initial	8.5	8.4	8.2	8.4	8.4	8.3
Specific Conductance, Initial micromhos	830	790	780	820	800	800

*Loss of ammonia nitrogen during aeration and sample preparation may have occured in all samples.
**Results not available.
B = Blank for turbidity measurement.

TABLE E-3 STATIC BIOASSAY DATA, SAMPLING SITE NO. 2 (Unfed Organisms)

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	100	90	100	100	100
- 24	100	100	80	100	100	90
- 36	100	90	50	0	90	80
- 48	80	90	30	0	90	80
- 60	70	70	30	0	80	80
- 72	40	70	30	0	80	80
- 84	30	70	20	0	80	80
- 96	30	70	20	0	80	80
Physical and Chemical Data						
Ammonia Nitrogen mg/l *						
Initial						
Final						
Dissolved Oxygen mg/l						
Initial	8.9	8.9	8.7	8.8	8.7	8.7
Final	8.8	8.4	8.2	8.6	8.7	8.7
Turbidity; Initial JTU	2	4	11	B	B	B
pH Initial	8.4	8.3	8.2	8.4	8.4	8.3
Specific Conductance, Initial μ mhos	920	950	980	920	920	970

*Data not available.

B = Blank for turbidity measurement.

TABLE E-4 STATIC BIOASSAY DATA, SAMPLING SITE NO. 2 (Organisms were fed)

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate 6%	Elutriate 20%	Control River Water	Elutriate 6%	Elutriate 20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	100	100	100	100	100
- 24	60	100	100	0	100	90
- 36	60	90	100	0	100	90
- 48	50	90	100	0	100	90
- 60	30	70	100	0	100	80
- 72	10	60	100	0	100	80
- 84	10	50	100	0	100	80
- 96	10	50	100	0	100	80
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	4.2	5.4	14.1	5.7	11.1	17.0
Final	4.2	9.7	15.2	4.9	9.4	15.8
Dissolved Oxygen mg/l						
Initial	9.4	9.3	7.7	9.2	9.3	8.1
Final	6.0	6.0	5.0	6.2	5.9	5.4
Turbidity: Initial JTU	2	10	14	B	B	B
pH Initial	8.5	8.4	8.2	8.5	8.4	8.3
Specific Conductance, Initial μ mhos	890	900	940	890	900	920

*Those organisms in 6% filtered were healthiest, exhibiting significant increase in size and greater mobility than other survivors.

B = Blank for turbidity measurement.

TABLE E-5 STATIC BIOASSAY DATA, SAMPLING SITE NO. 3 (Unfed Organisms)

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	90	100	100	70	50	70
- 24	80	100	100	50	50	50
- 36	70	80	100	30	50	40
- 48	50	60	90	10	40	30
- 60	50	40	90	10	20	20
- 72	50	30	80	0	10	10
- 84	40	20	70	0	10	10
- 96	30	10	40	0	10	10
Physical and Chemical Data						
Ammonia Nitrogen mg/l *						
Initial						
Final						
Dissolved Oxygen mg/l						
Initial	8.7	8.7	8.5	8.4	8.9	8.4
Final	8.4	8.2	8.1	8.2	8.6	8.3
Turbidity; Initial JTU	0	0	14	B	B	B
pH Initial	8.2	8.0	8.0	8.3	8.2	8.2
Specific Conductance, Initial μ mhos	920	920	920	900	910	910

*Data not available.
B = Blank for turbidity measurement.

TABLE E-6 STATIC BIOASSAY DATA, SAMPLING SITE NO. 3 (Organisms were fed

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6	20		6	20
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	100	100	100	100	100
- 24	100	100	100	100	100	100
- 36	80	90	100	100	100	100
- 48	80	90	90	100	100	100
- 60	60	80	90	90	100	100
- 72	50	70	90	90	100	100
- 84	40	50	90	90	100	100
- 96	40	50	90	90	100	100
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	4.6	4.5	4.4	5.6	4.5	4.4
Final	3.6	2.6	2.5	4.8	3.8	2.6
Dissolved Oxygen mg/l						
Initial	10.8	10.8	10.6	10.8	10.8	10.6
Final	6.1	5.7	6.2	5.8	5.6	6.3
Turbidity: Initial JTU	0	1	4	B	B	B
pH Initial	8.4	8.4	8.3	8.5	8.4	8.4
Specific Conductance, Initial micromhos	850	840	860	860	850	850

B = Blank for turbidity measurement.

TABLE E-7 STATIC BIOASSAY DATA, SAMPLING SITE NO. 4

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	30	20	20	30	20	80
- 24	0	0	0	20	10	70
- 36	0	0	0	20	10	60
- 48	0	0	0	0	10	60
- 60	0	0	0	0	0	40
- 72	0	0	0	0	0	40
- 84	0	0	0	0	0	30
- 96	0	0	0	0	0	10
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	8.5	9.9	11.5	9.2	10.4	11.9
Final	9.9	10.5	10.5	10.4	10.8	12.0
Dissolved Oxygen mg/l						
Initial	9.8	9.4	9.1	10.1	9.9	9.8
Final	7.7	7.5	7.8	8.1	8.1	7.6
Turbidity; Initial JTU	1	12	6	B	B	B
pH Initial	8.0	7.9	7.9	8.1	8.2	8.2
Specific Conductance, Initial µ mhos	900	900	900	860	860	900

B = Blank for turbidity measurement.

TABLE E-8 STATIC BIOASSAY DATA, SAMPLING SITE NO.5

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	60	40	50	30	60	70
- 24	40	10	20	0	10	40
- 36	20	0	0	0	0	20
- 48	0	0	0	0	0	20
- 60	0	0	0	0	0	20
- 72	0	0	0	0	0	20
- 84	0	0	0	0	0	20
- 96	0	0	0	0	0	20
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	8.3	20.4	47.0	8.4	20.2	36.7
Final	8.1	19.9	34.5	7.9	19.6	36.1
Dissolved Oxygen mg/l						
Initial	10.6	10.2	9.0	10.6	10.2	9.1
Final	7.9	8.1	5.4	8.3	8.2	6.4
Turbidity, Initial JTU	8	6	31	B	B	B
pH Initial	8.0	8.0	8.0	8.1	8.2	8.0
Specific Conductance, Initial , mhos	820	950	1280	810	950	1180

B = Blank for turbidity measurement.

TABLE E-9 STATIC BIOASSAY DATA, SAMPLING SITE NO.6

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	60	60	20	60	80	10
- 24	40	20	0	10	80	10
- 36	10	10	0	10	60	10
- 48	0	0	0	0	50	10
- 60	0	0	0	0	50	10
- 72	0	0	0	0	50	10
- 84	0	0	0	0	50	10
- 96	0	0	0	0	50	10
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	8.6	21.6	37.2	8.4	21.5	33.4
Final	8.4	21.4	37.1	8.0	20.5	33.2
Dissolved Oxygen mg/l						
Initial	8.6	5.2	0.7	8.7	7.1	2.8
Final	8.5	7.6	6.0	8.3	8.2	6.7
Turbidity; Initial JTU	0	43	85	B	B	B
pH Initial	8.1	8.0	7.9	8.4	8.2	8.2
Specific Conductance, Initial µmhos	700	780	940	680	760	940

B = Blank for turbidity measurement.

TABLE E-10 STATIC BIOASSAY DATA, SAMPLING SITE NO. 7

TESTS PERFORMED	Centrifuged Sample *			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	90	90	100	90	90	100
- 24	90	90	100	80	90	100
- 36	50	80	80	80	80	100
- 48	30	60	80	30	80	100
- 60	0	30	40	30	80	100
- 72	0	20	20	20	80	100
- 84	0	0	0	0	70	100
- 96	0	0	0	0	70	100
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	5.2	4.2	2.3	4.6	2.2	1.5
Final	2.1	0.8	<0.02	4.3	2.1	1.5
Dissolved Oxygen mg/l						
Initial	8.5	8.5	8.2	9.0	8.4	7.8
Final	12.8	13 5	14.4	8.1	7.8	7.4
Turbidity; Initial JTU	13	15	10	B	B	B
pH Initial	8.1	7.9	7.8	8.3	8.1	8.1
Specific Conductance, Initial μ mhos	670	680	680	680	680	680

*Heavy algal growth accounts for high final DO and low final AN.

B - Blank for turbidity measurement.

TABLE E-11 STATIC BIOASSAY DATA, SAMPLING SITE NO.8

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	80	100	100	90	100
- 24	40	30	80	60	50	80
- 36	40	30	60	50	20	40
- 48	10	0	30	40	0	30
- 60	0	0	10	10	0	10
- 72	0	0	0	10	0	10
- 84	0	0	0	10	0	10
- 96	0	0	0	0	0	10
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	7.5	5.7	3.8	6.7	6.2	4.3
Final	7.6	4.6	4.2	5.9	6.1	3.6
Dissolved Oxygen mg/l						
Initial	9.0	9.0	9.0	8.6	8.3	9.0
Final	8.5	8.6	8.2	8.4	8.5	8.6
Turbidity; Initial JTU	9	15	15	B	B	B
pH Initial	8.1	8.2	8.1	8.3	8.3	8.3
Specific Conductance, Initial .. mhos	660	660	670	640	640	680

B = Blank for turbidity measurement.

TABLE E-12 STATIC BIOASSAY DATA, SAMPLING SITE NO. 9

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	100	100	100	100	100
- 24	100	100	100	100	100	100
- 36	100	100	100	100	100	100
- 48	100	90	100	100	90	100
- 60	100	90	100	100	90	100
- 72	100	90	90	100	90	100
- 84	100	90	90	100	90	100
- 96	100	90	90	100	90	100
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	3.00	0.70*	0.40*	2.80	0.20*	<0.02
Final	2.80	2.00	0.90	2.40	1.70	1.40
Dissolved Oxygen mg/l						
Initial	9.7	9.1	8.6	8.5	8.3	8.5
Final	8.2	8.2	8.0	8.2	8.2	8.0
Turbidity; Initial JTU	5	11	14	B	B	B
pH Initial	8.1	8.1	7.8	8.2	8.1	8.1
Specific Conductance, Initial μ mhos	670	660	660	670	660	670

*Later tests showed the indicator used for these results was weak.

B = Blank for turbidity measurement.

TABLE E-13 STATIC BIOASSAY DATA, SAMPLING SITE NO.10

TESTS PERFORMED	Centrifuged Sample *			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	90	100	100	100	100
- 24	100	90	100	100	100	100
- 36	100	90	100	100	100	100
- 48	100	90	100	100	100	100
- 60	100	90	100	100	100	100
- 72	100	90	100	100	100	100
- 84	100	90	100	100	100	100
- 96	100	90	100	100	100	100
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	3.40	2.30	1.10	2.70	1.10	1.10
Final	2.30	2.10	0.03	2.10	1.10	0.70
Dissolved Oxygen mg/l						
Initial	8.4	8.4	8.7	8.4	8.4	8.6
Final	11.9	12.6	13.8	7.8	7.6	7.4
Turbidity; Initial JTU	9	10	10	B	B	B
pH Initial	8.2	8.0	8.0	8.3	8.2	8.2
Specific Conductance, Initial μ mhos	610	600	690	610	580	580

*Heavy algae growth in centrifuged water. Organisms in filtered water, while surviving, were significantly smaller than those in unfiltered (centrifuged) water.

B = Blank for turbidity measurement.

TABLE E-14 STATIC BIOASSAY DATA, SAMPLING SITE NO. 11

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	80	100	100	100	100	100
- 24	60	90	100	90	100	100
- 36	60	90	100	90	100	100
- 48	50	90	100	90	100	100
- 60	50	90	100	90	100	100
- 72	50	90	100	90	100	100
- 84	40	90	100	70	80	70
- 96	40	90	100	60	70	70
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	<.02	0.23	<.02	<.02	0.11	<.02
Final	0.68	1.24	<.02	0.28	0.56	<.02
Dissolved Oxygen mg/l						
Initial	9.5	9.3	8.9	8.3	8.3	8.0
Final	8.7	8.7	8.8	8.8	8.6	8.7
Turbidity; Initial JTU	5	5	9	B	B	B
pH Initial	8.1	7.9	7.9	8.2	8.2	8.1
Specific Conductance, Initial μ mhos	510	520	520	520	510	520

B = Blank for turbidity measurement.

TABLE E-15 STATIC BIOASSAY DATA, SAMPLING SITE NO. 12

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	100	100	100	100	100
- 24	100	100	90	100	100	100
- 36	100	100	90	100	100	100
- 48	100	100	90	100	100	100
- 60	100	100	90	100	100	100
- 72	100	100	90	100	100	100
- 84	100	100	90	100	100	100
- 96	100	100	90	100	100	100
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	0.16	0.97	2.34	0.05	0.09	1.97
Final	<.02	<.02	<.02	<.02	0.45	1.79
Dissolved Oxygen mg/l						
Initial	8.7	8.2	6.2	8.0	7.5	7.8
Final	8.0	7.8	7.5	7.5	7.5	7.3
Turbidity; Initial JTU	31	240	180	B	B	B
pH Initial	7.9	7.7	7.5	8.1	8.1	8.2
Specific Conductance, Initial μ mhos	230	270	360	220	270	370

Survivors active but very small.

B = Blank for turbidity measurement.

TABLE E-16 STATIC BIOASSAY DATA, SAMPLING SITE NO. 13

TESTS PERFORMED	Centrifuged Sample			Filtered Samples		
	Control River Water	Elutriate		Control River Water	Elutriate	
		6%	20%		6%	20%
Percent Survival						
Hours - 0	100	100	100	100	100	100
- 2	100	100	100	100	100	100
- 12	100	100	100	30	100	100
- 24	100	90	100	30	100	90
- 36	100	90	100	30	100	90
- 48	100	90	100	30	100	70
- 60	100	90	100	20	100	40
- 72	100	90	100	10	100	30
- 84	100	90	100	10	100	30
- 96	100	90	100	10 *	100	30 *
Physical and Chemical Data						
Ammonia Nitrogen mg/l						
Initial	0.36	0.07	.03	0.12	0.07	0.02
Final	<.02	<.02	<.02	<.02	<.02	<.02
Dissolved Oxygen mg/l						
Initial	8.6	8.9	8.3	7.6	7.6	7.3
Final	8.3	8.4	8.2	7.5	7.5	7.3
Turbidity; Initial JTU	6	85	110	B	B	B
pH Initial	8.0	8.0	8.0	8.0	8.1	8.0
Specific Conductance, Initial μ mhos	330	330	330	320	320	330

*See discussion.

B = Blank for turbidity measurement.

APPENDIX F

GRAIN SIZE DISTRIBUTION OF BOTTOM SEDIMENTS

FIGURE F-1. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 1

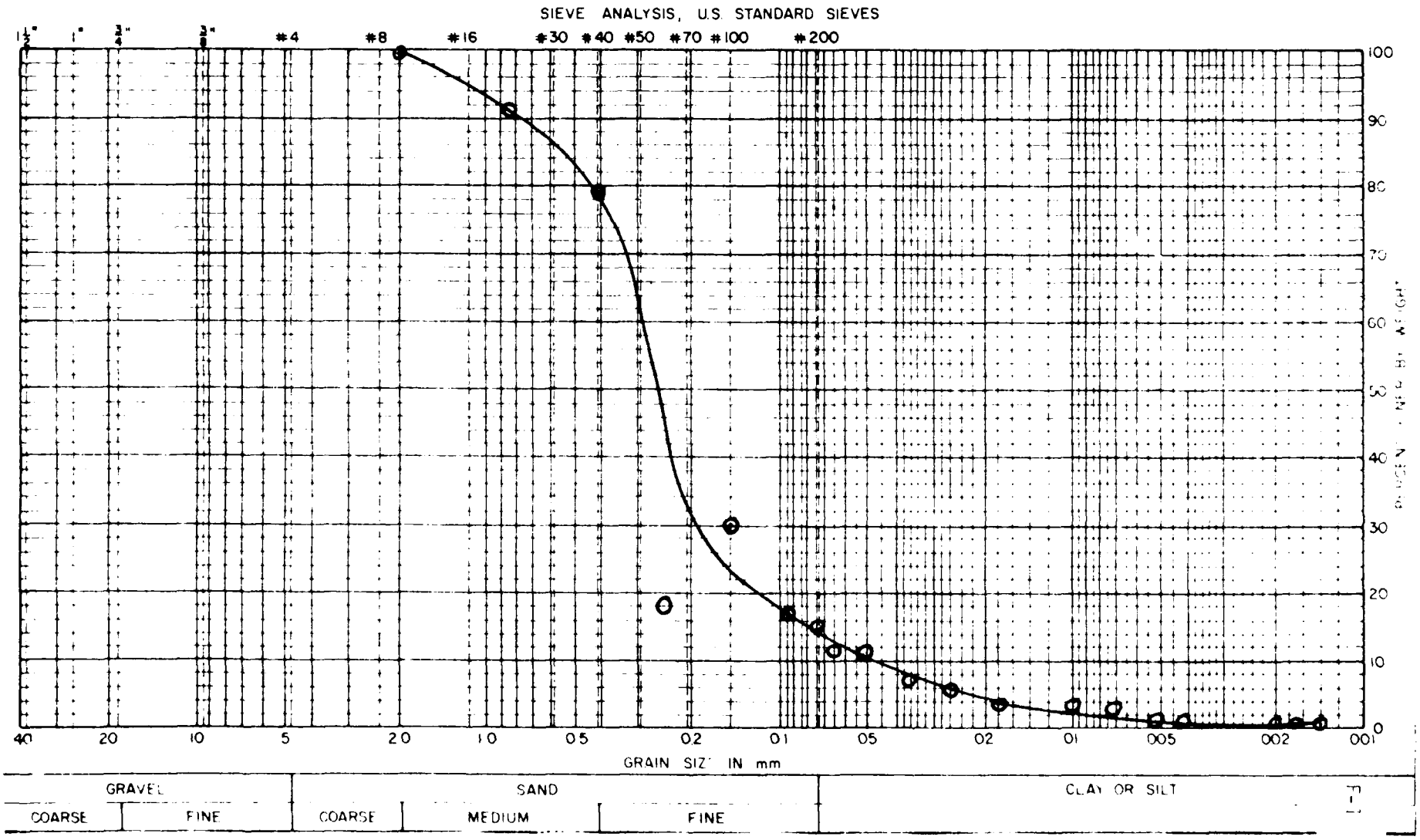


FIGURE F-2. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 2

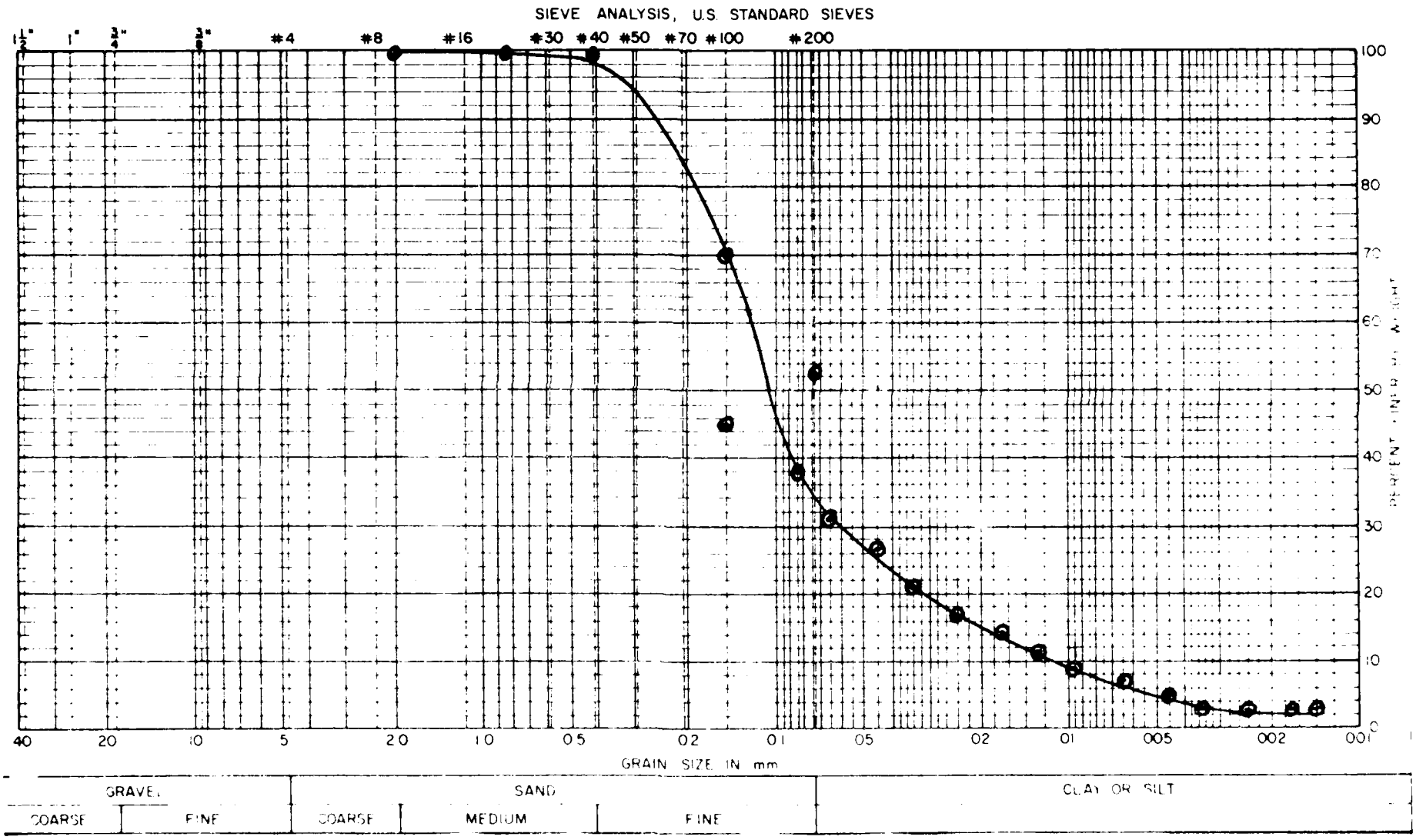
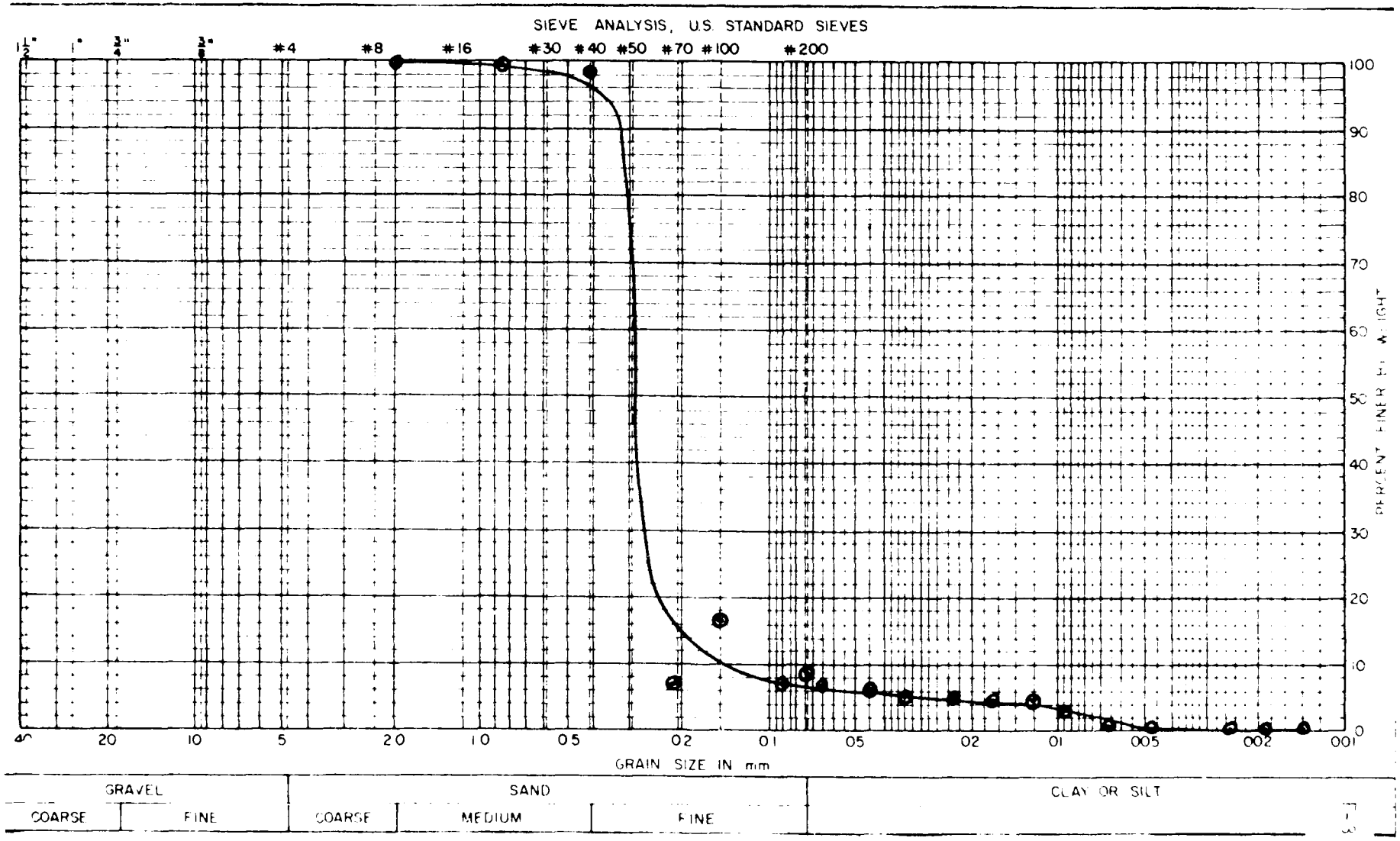


FIGURE F-3. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 3



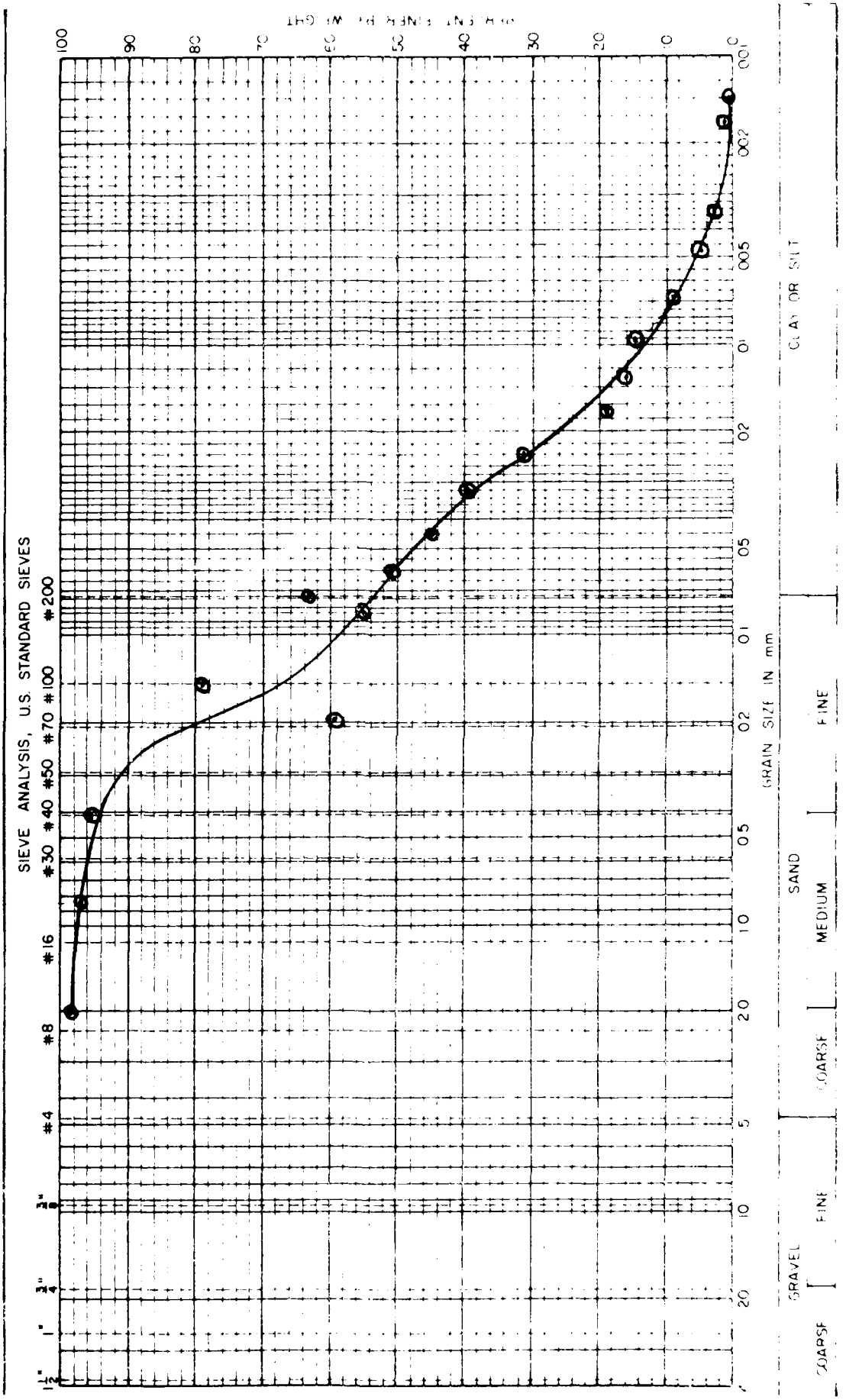


FIGURE F-4. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 4

FIGURE F-5. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 5

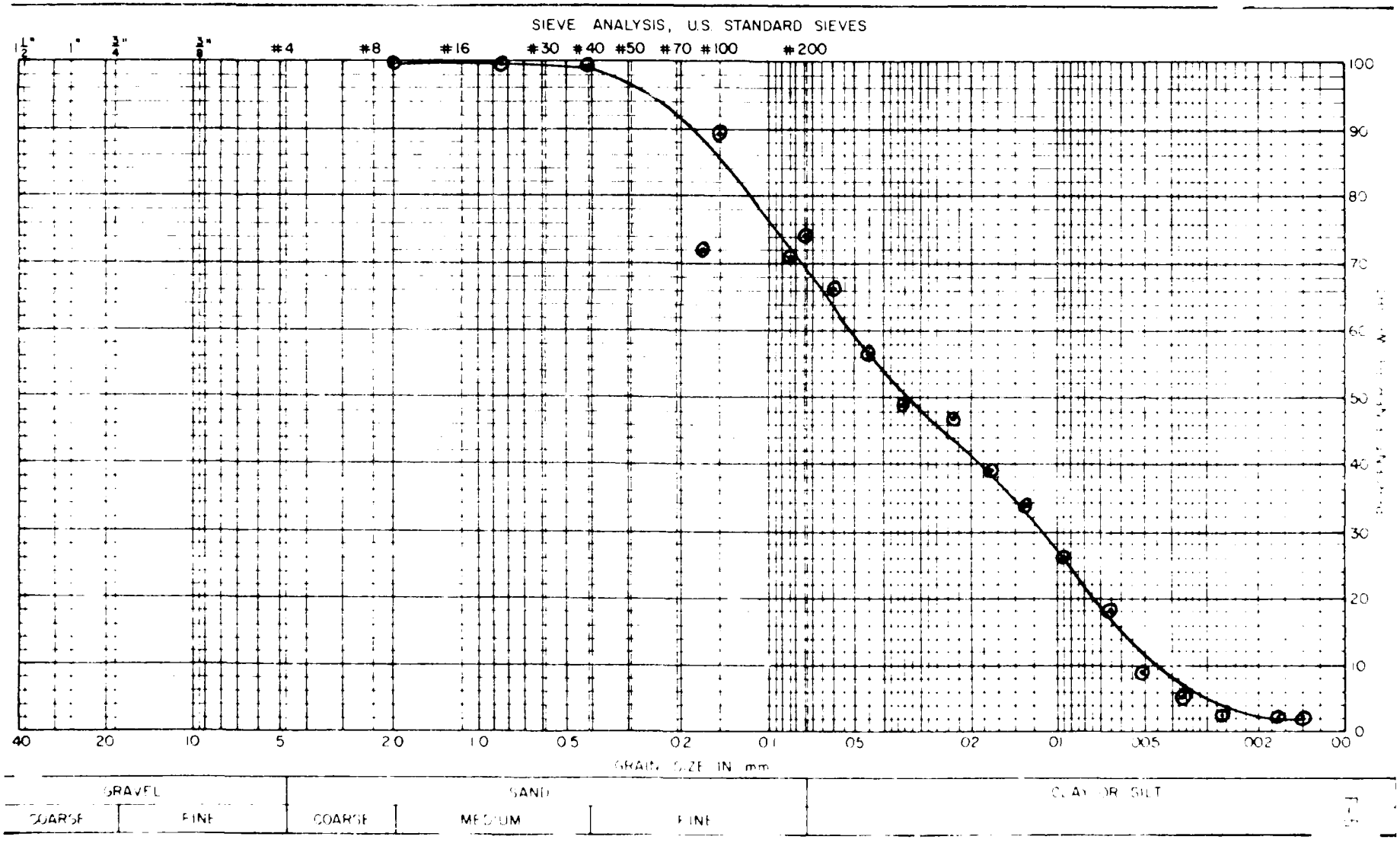


FIGURE F-6. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 6

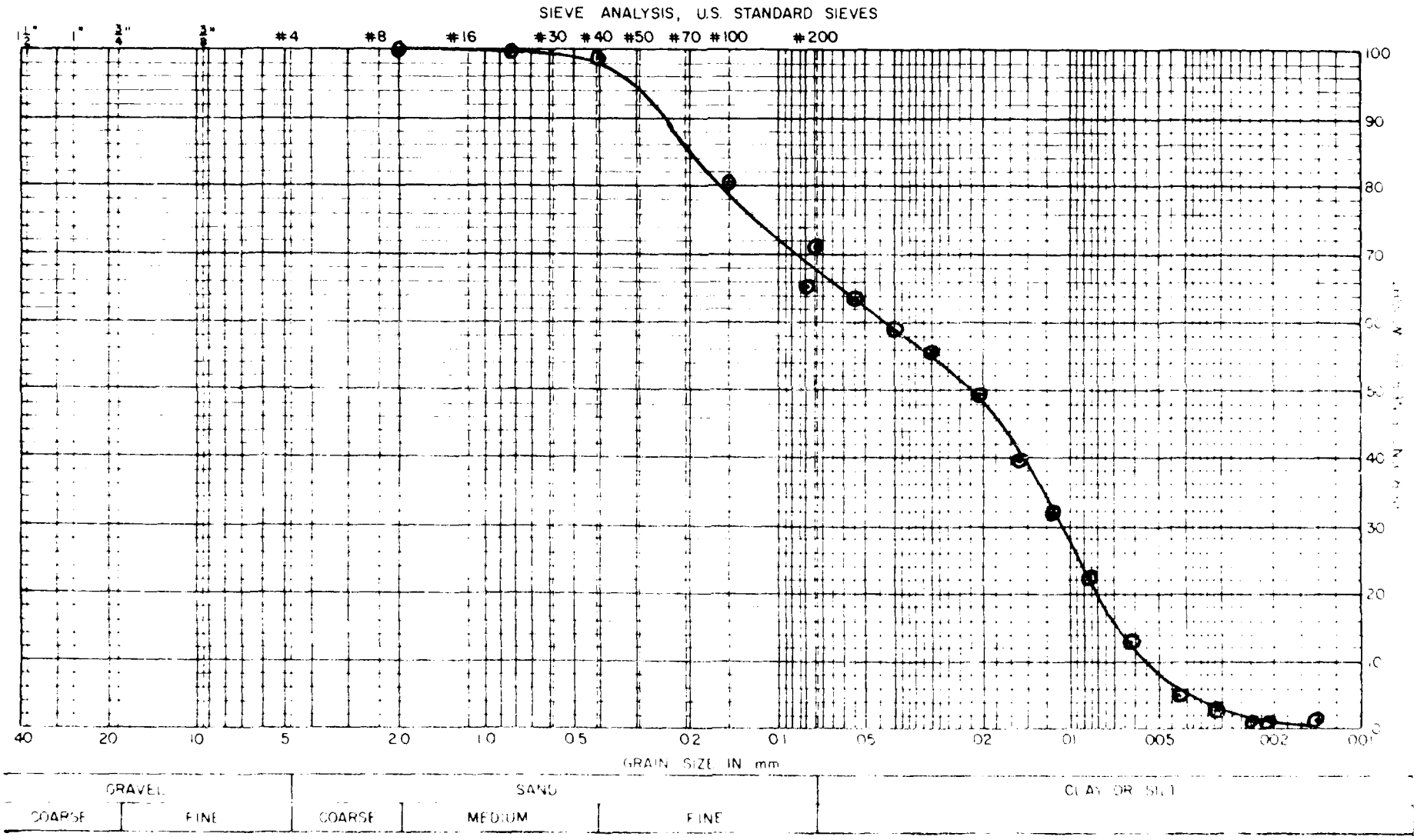


FIGURE F-7 GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 7

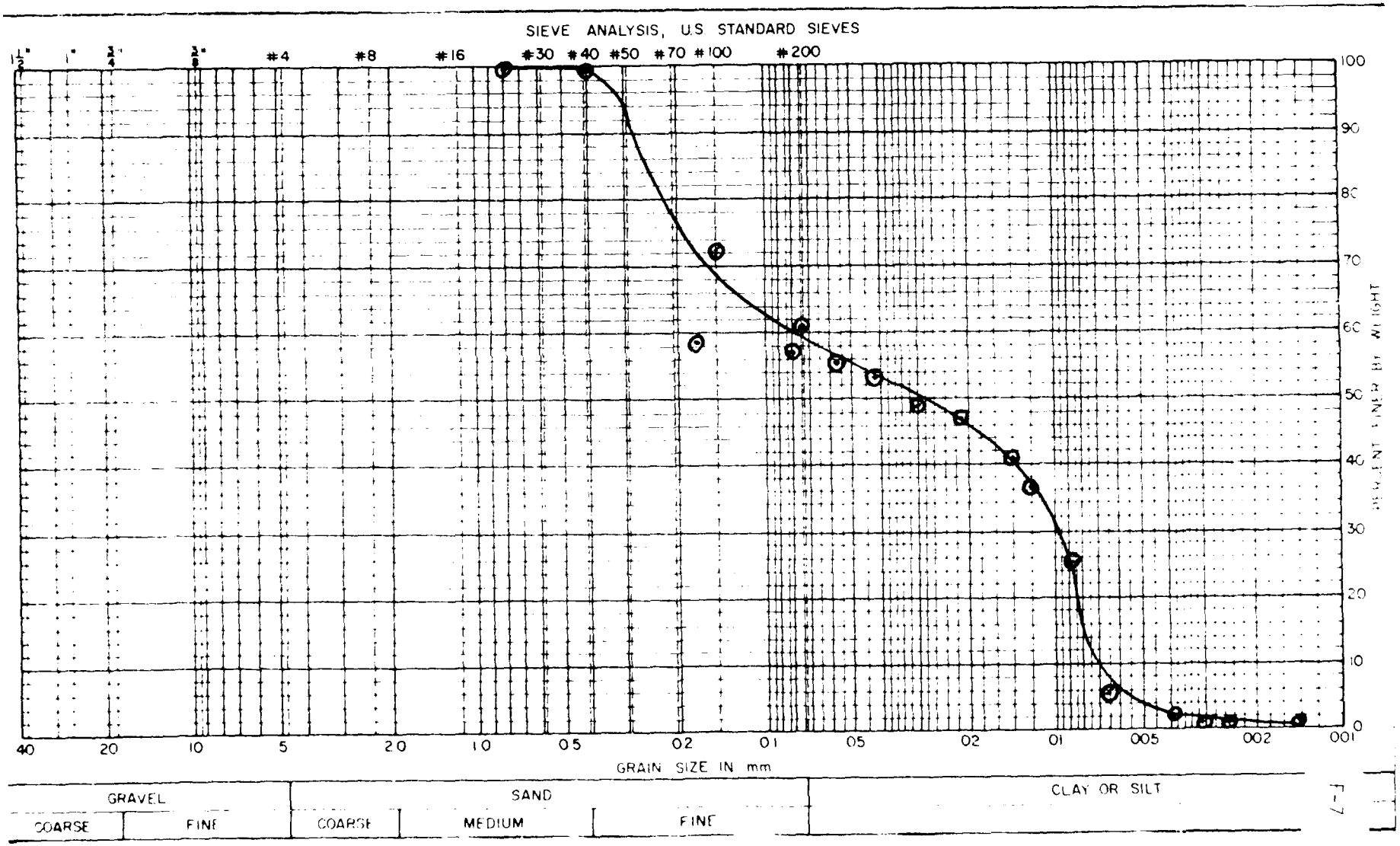


FIGURE F-8. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 8

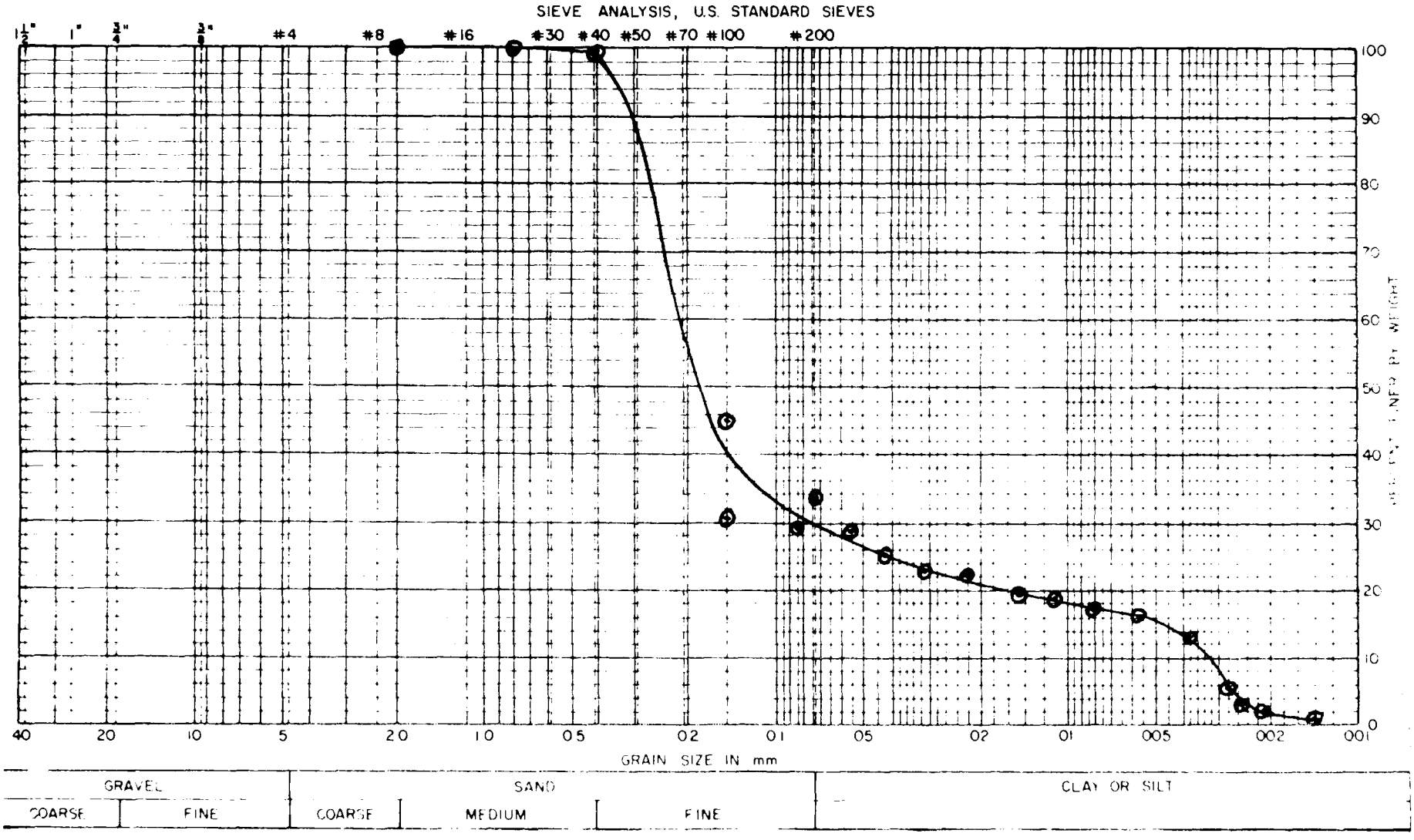
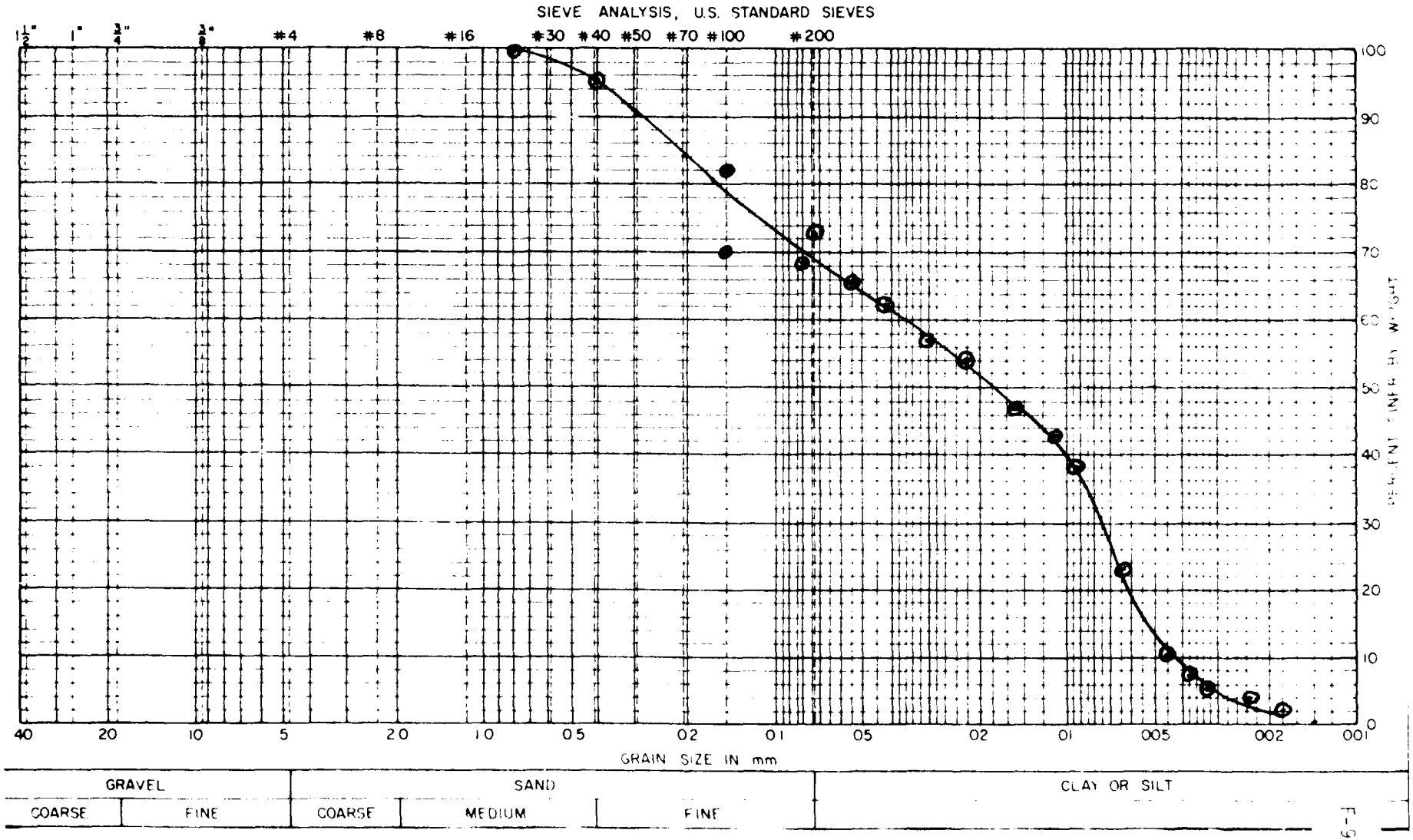


FIGURE F-9. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 9



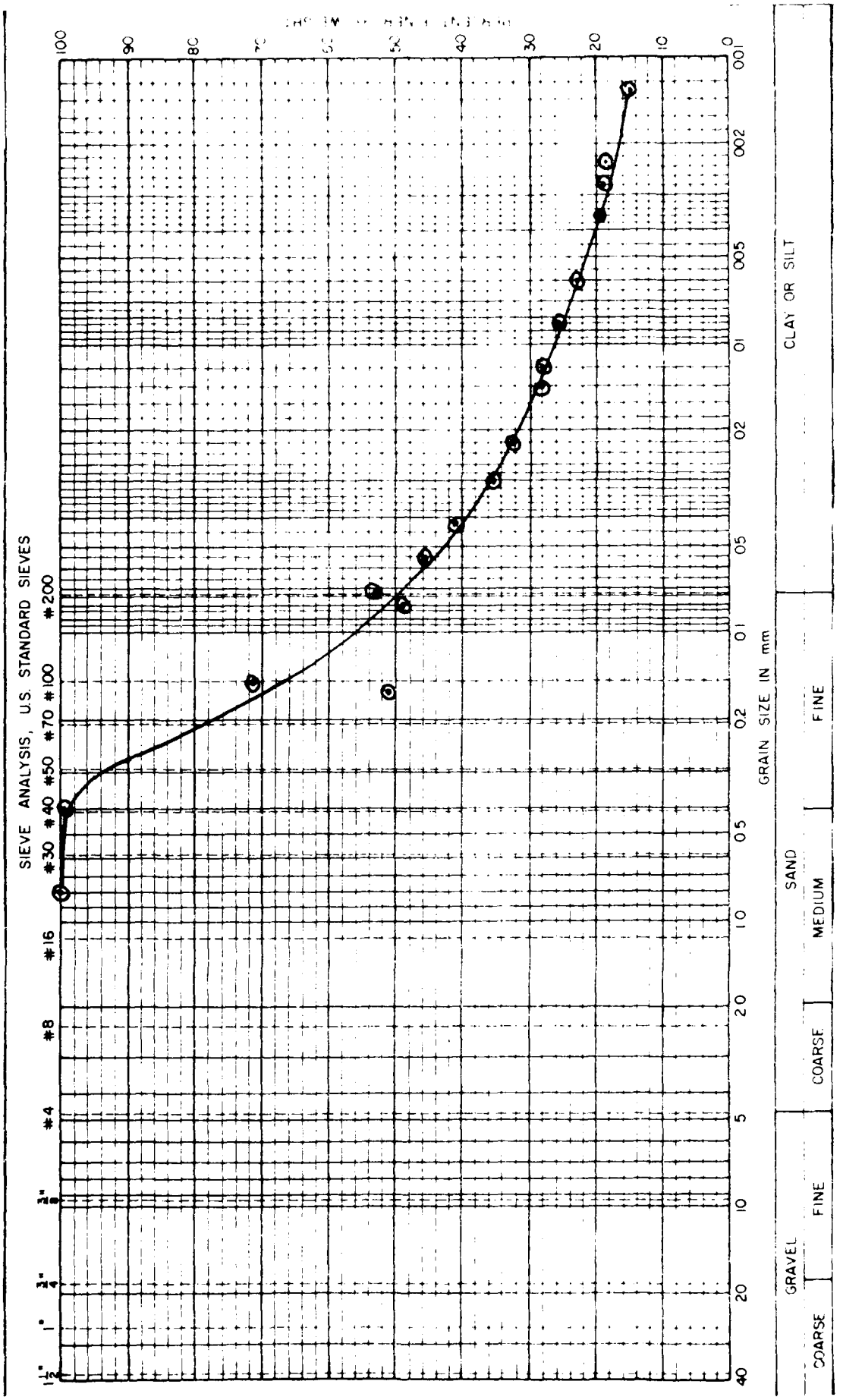


FIGURE F-10. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 10

FIGURE F-11. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 11

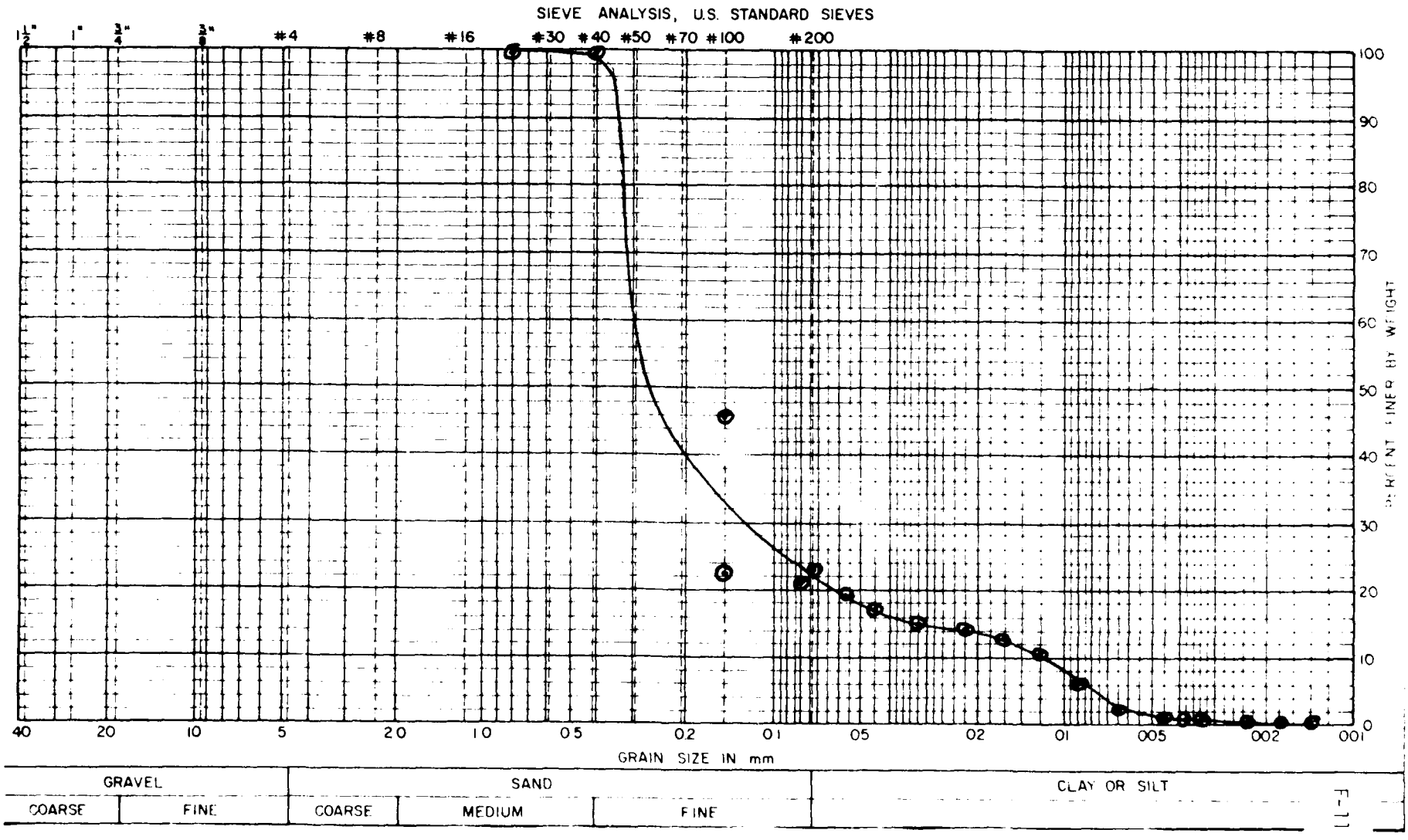


FIGURE F-12. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 12

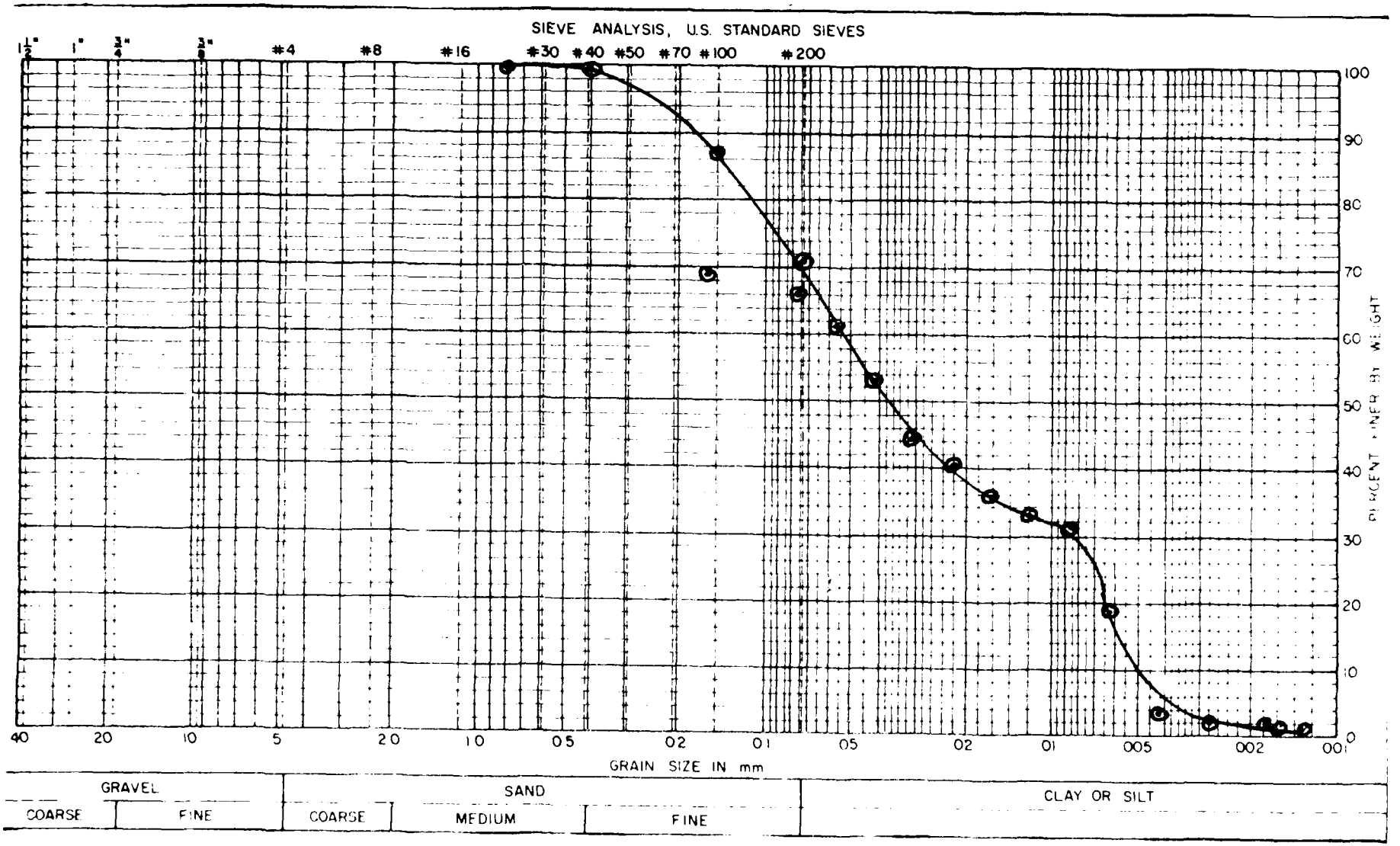
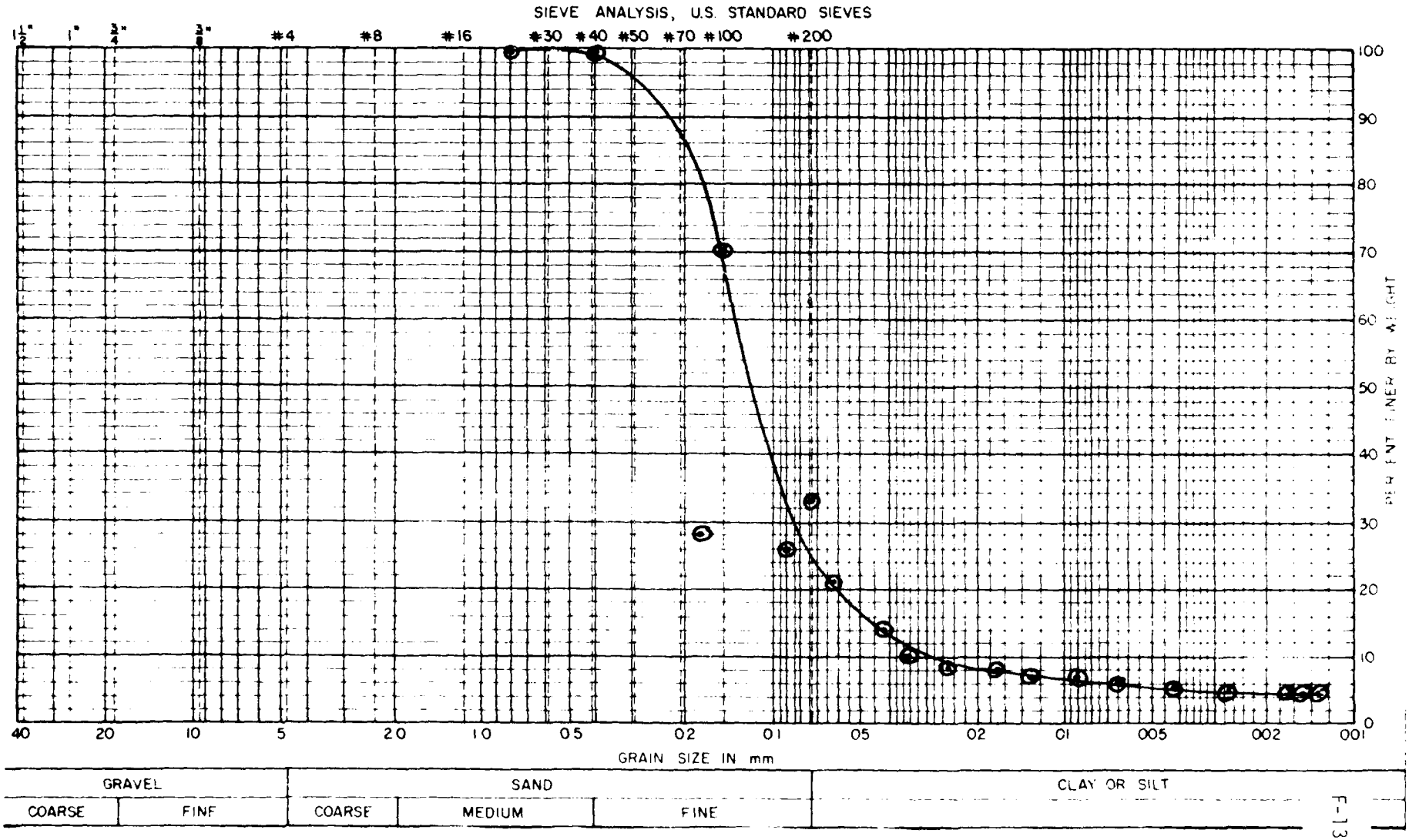


FIGURE F-13. GRAIN SIZE DISTRIBUTION IN BOTTOM SEDIMENT FROM SAMPLING SITE NO. 13



APPENDIX G

GRAPHICAL REPRESENTATION OF RESULTS OF VARIOUS PARAMETERS IN RIVER WATER AND ELUTRIATES

APPENDIX G

GRAPHICAL REPRESENTATION OF RESULTS OF VARIOUS PARAMETERS IN RIVER WATER AND ELUTRIATES

General

The computer graphics have been prepared to represent the measured concentrations of various parameters in the river water, elutriates, and bottom sediments with respect to the Corps river miles. The purpose is to provide a visual aid in determining how the concentrations of these parameters decrease or increase along the river length. Also, the recommended limits of these parameters have been shown on various graphs to indicate in which reaches of the river the concentrations of various parameters are above or below the recommended limits.

The plotted results of river water and elutriates are given in Appendix G. The plots of bottom sediments are given in Appendix H.

Graphical Representation of Results in Water and Elutriates

The plotted results of filtered river water and elutriates are presented separate from those of unfiltered samples. In addition, a "change in concentration" (elutriates value - river water value) for filtered and unfiltered samples is also given in its respective plot. However, a separate ordinate is used for this purpose. A positive value indicates that elutriation increased the value of the particular chemical parameter, and a negative value indicates a decrease in the chemical parameter value after elutriation. All results for water and elutriates are in mg/ℓ.

Interpreting the Plots

(1) The following symbols are used:

Δ = change in concentrations

X = river water results

0 = elutriates results

(2) The Corps river miles have been shifted by 550 on the plot. This means 0 mile on X-axis is CRM 550. As the CRM decreases downstream, CRM 400 will be (550-400) = 150.

(3) Scientific notation is used on both axes. A reading of 1.920 E + 02 on X-axis means 192.0.

(4) In order to locate CRM 341.0 (Sampling Site 9), the following procedure may be used:

Reading on X-axis = (550.0 - 341.0) = 209.0. In scientific notation it will be 2.090 E + 02. This value is shown for the 9th plot on the X-axis.

(5) A reading of 1.600 E + 03 on X-axis means 1600.

TABLE OF CONTENTS

Figure Number and Description

FIGURE G-1 TOTAL SOLIDS (UNFILTERED) RIVER WATER AND ELUTRIATES

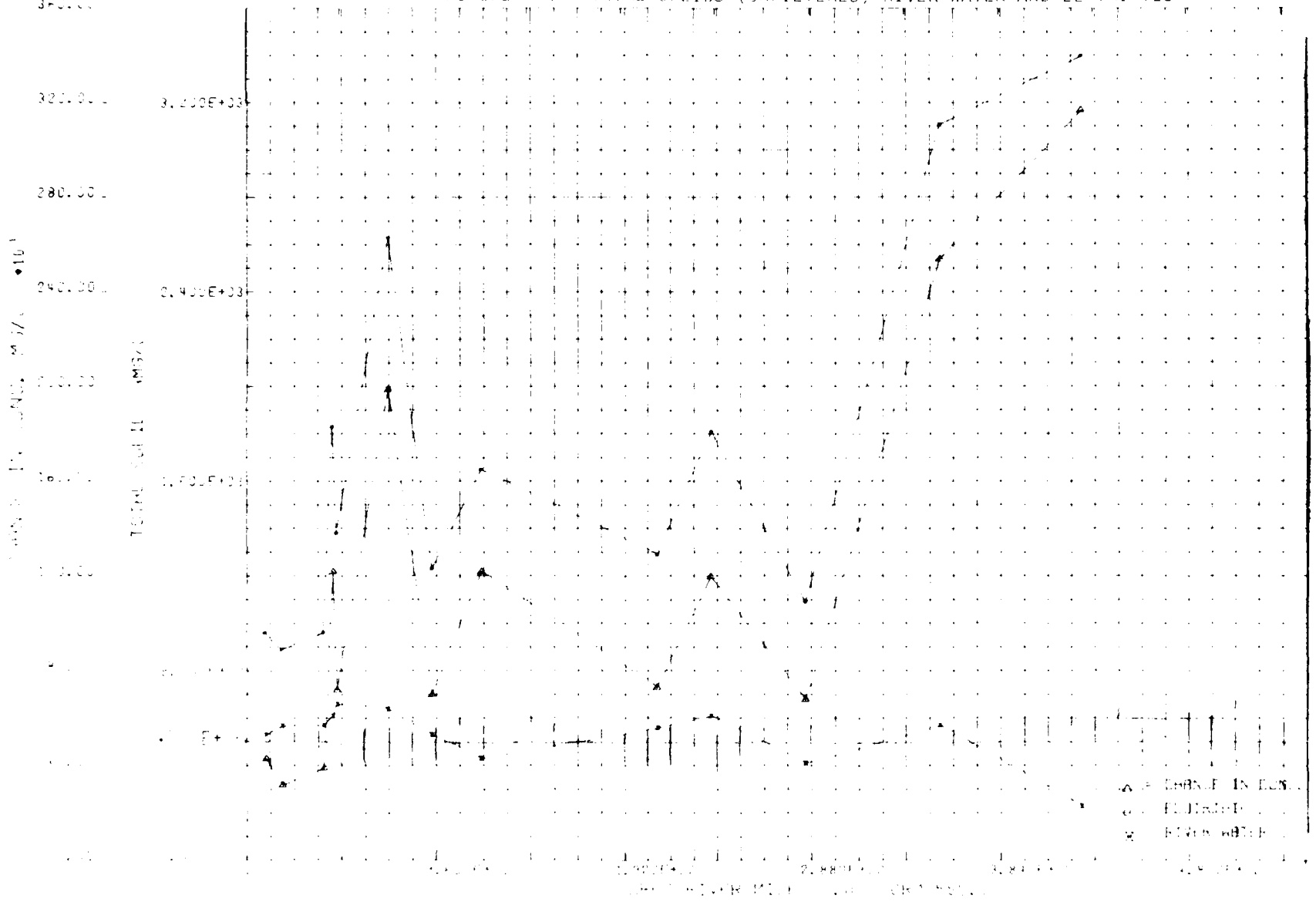
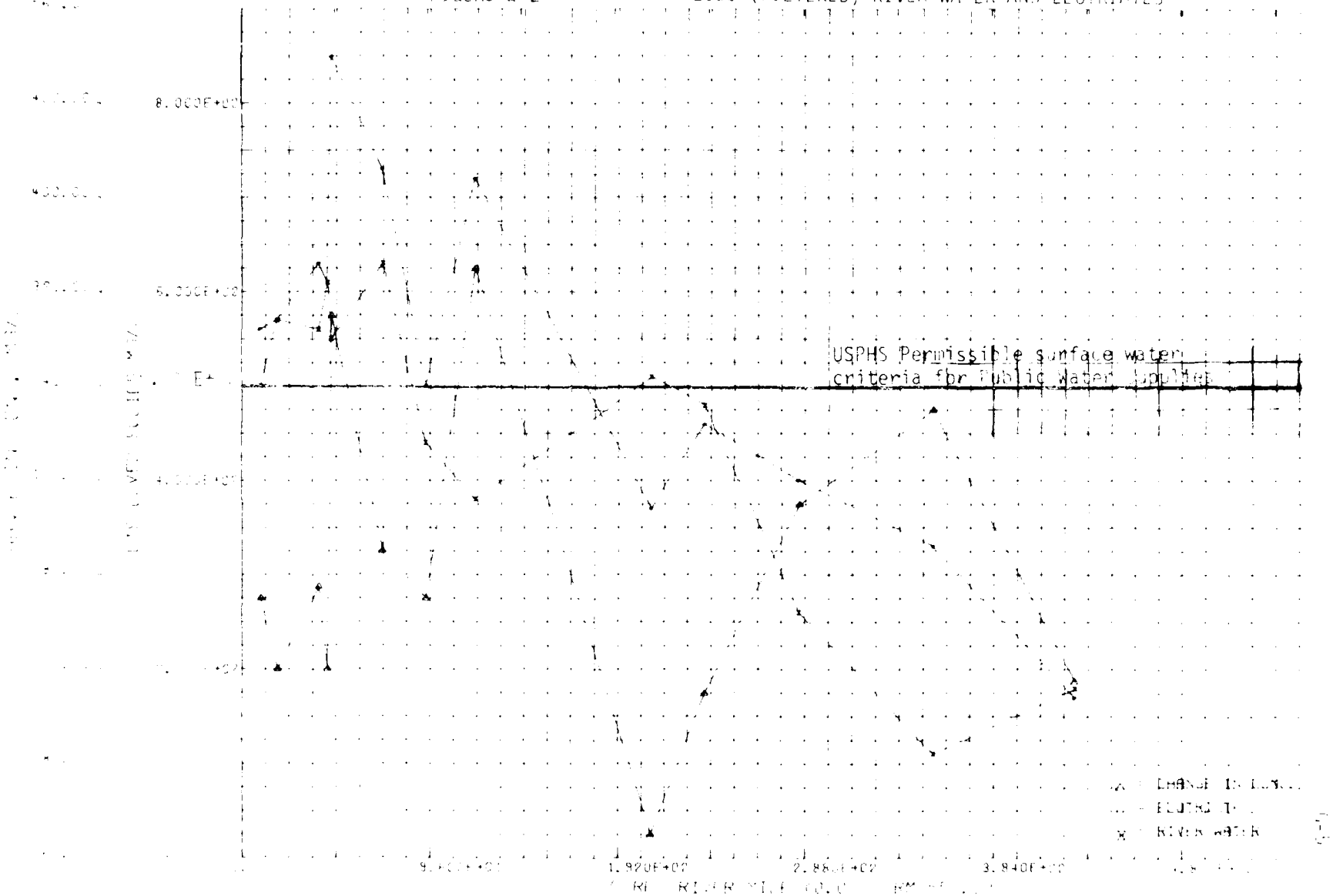
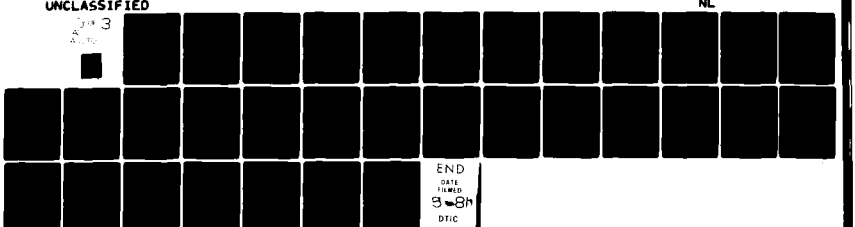
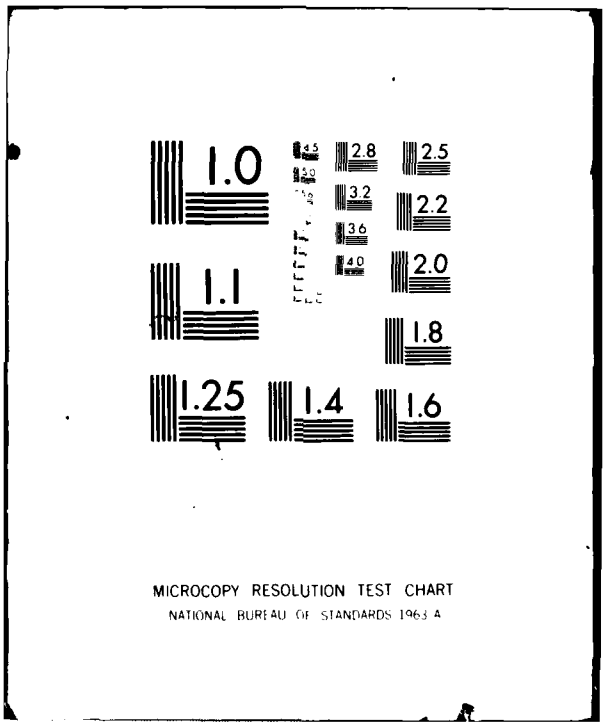


FIGURE G-2 DISSOLVED SOLIDS (FILTERED) RIVER WATER AND ELUTRIATES



AD-A097 087 TEXAS UNIV AT ARLINGTON F/G 8/8
TRINITY RIVER BOTTOM SEDIMENT RECONNAISSANCE STUDY,(U)
JUN 77 DACW63-76-C-0140
UNCLASSIFIED NL




1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

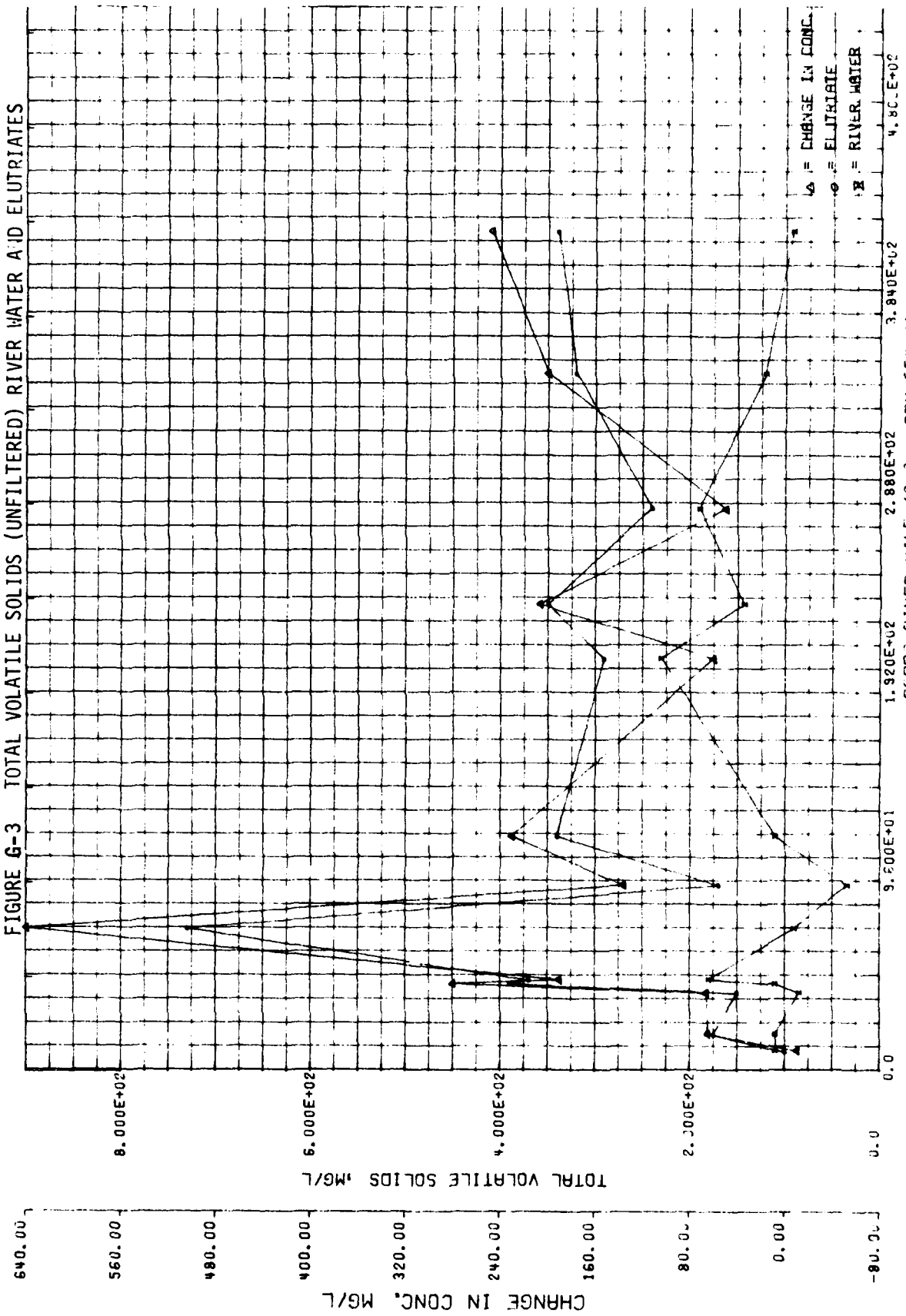
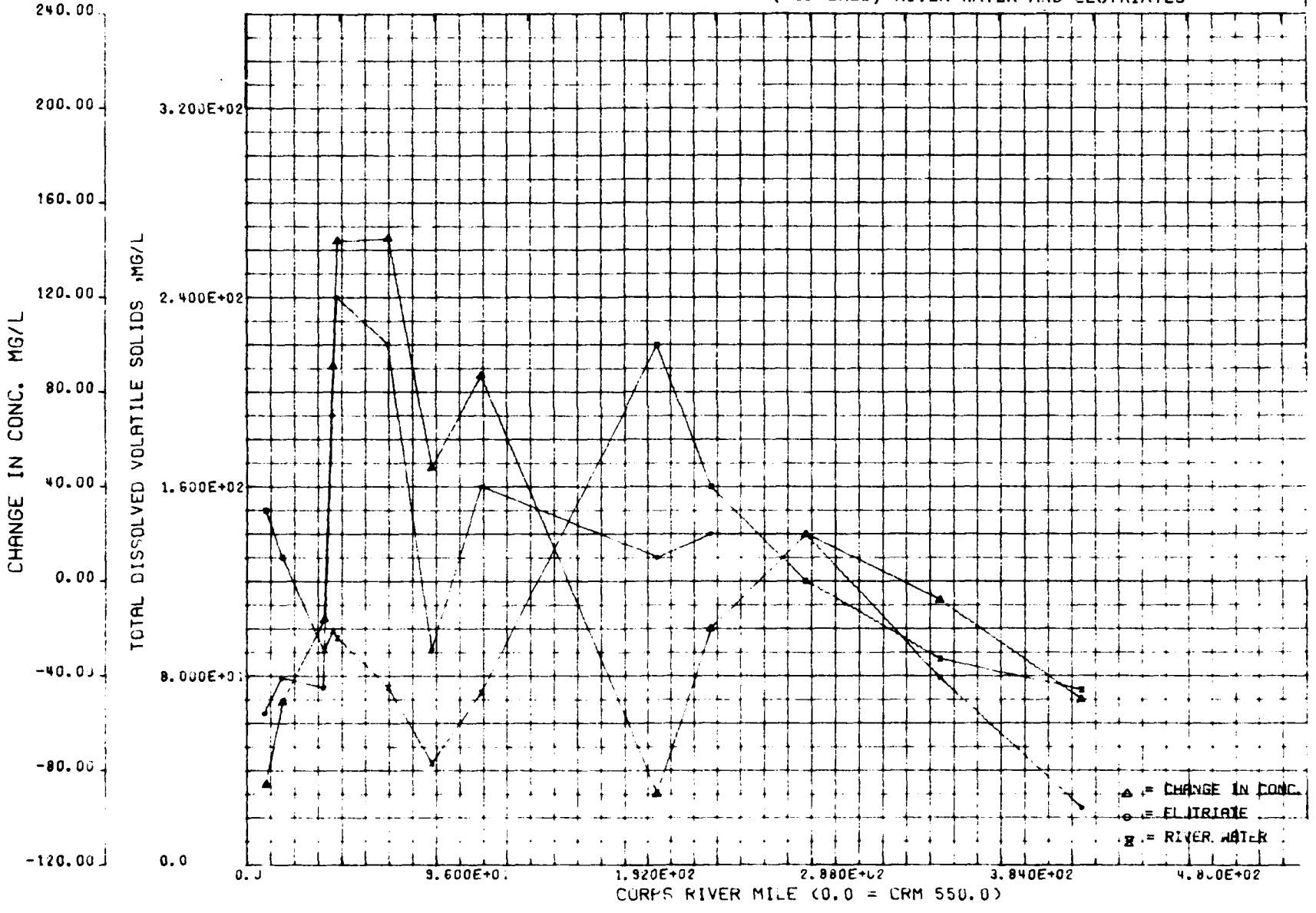


FIGURE G-3 TOTAL VOLATILE SOLIDS (UNFILTERED) RIVER WATER AND ELUTRIATES

FIGURE G-4 TOTAL DISSOLVED VOLATILE SOLIDS (FILTERED) RIVER WATER AND ELUTRIATES



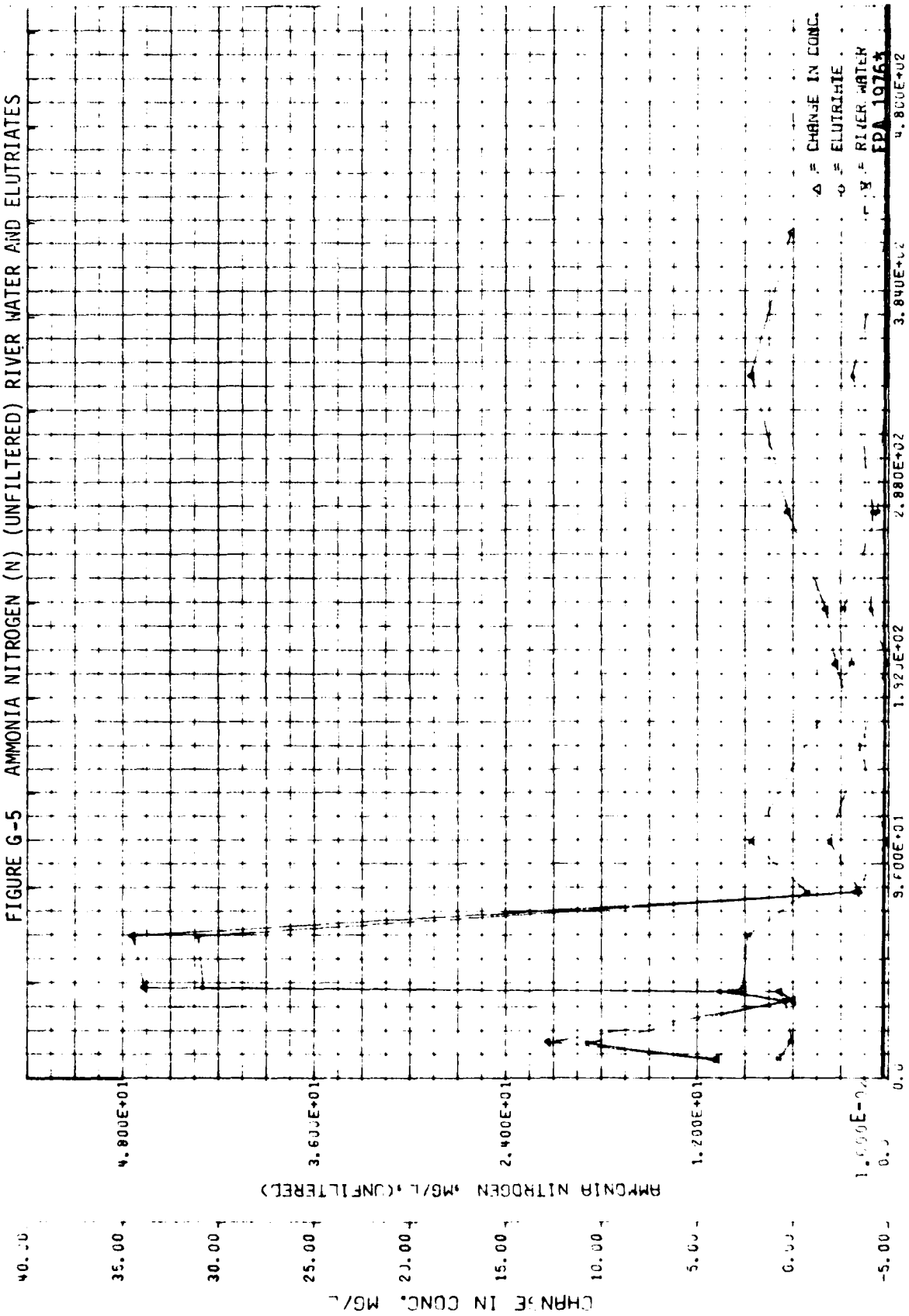
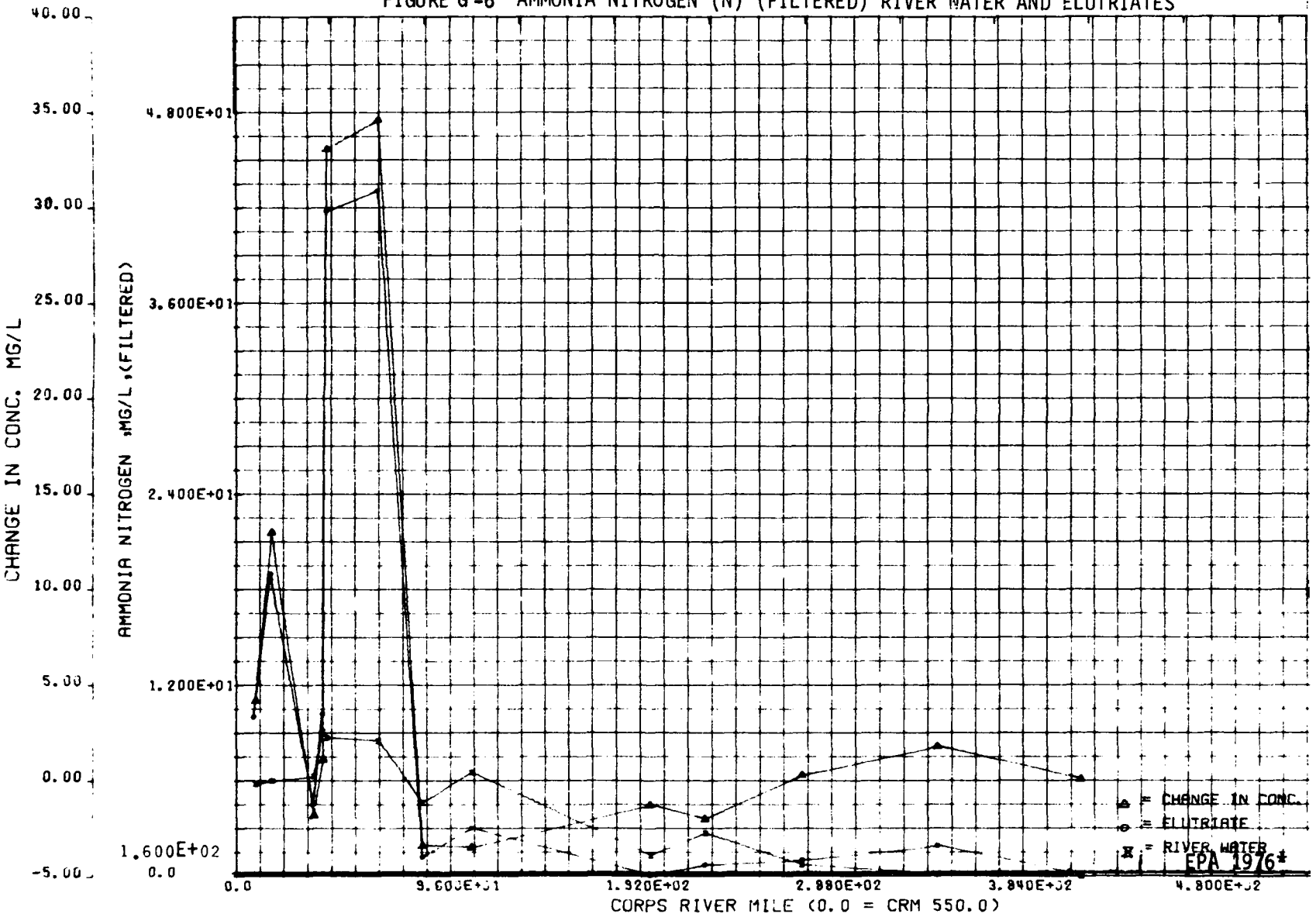


FIGURE G-5

* Domestic Water Supply, "Quality Criteria for Water," EPA 1976.

FIGURE G-6 AMMONIA NITROGEN (N) (FILTERED) RIVER WATER AND ELUTRIATES



* Domestic Water Supply, "Quality Criteria for Water, " EPA 1976.

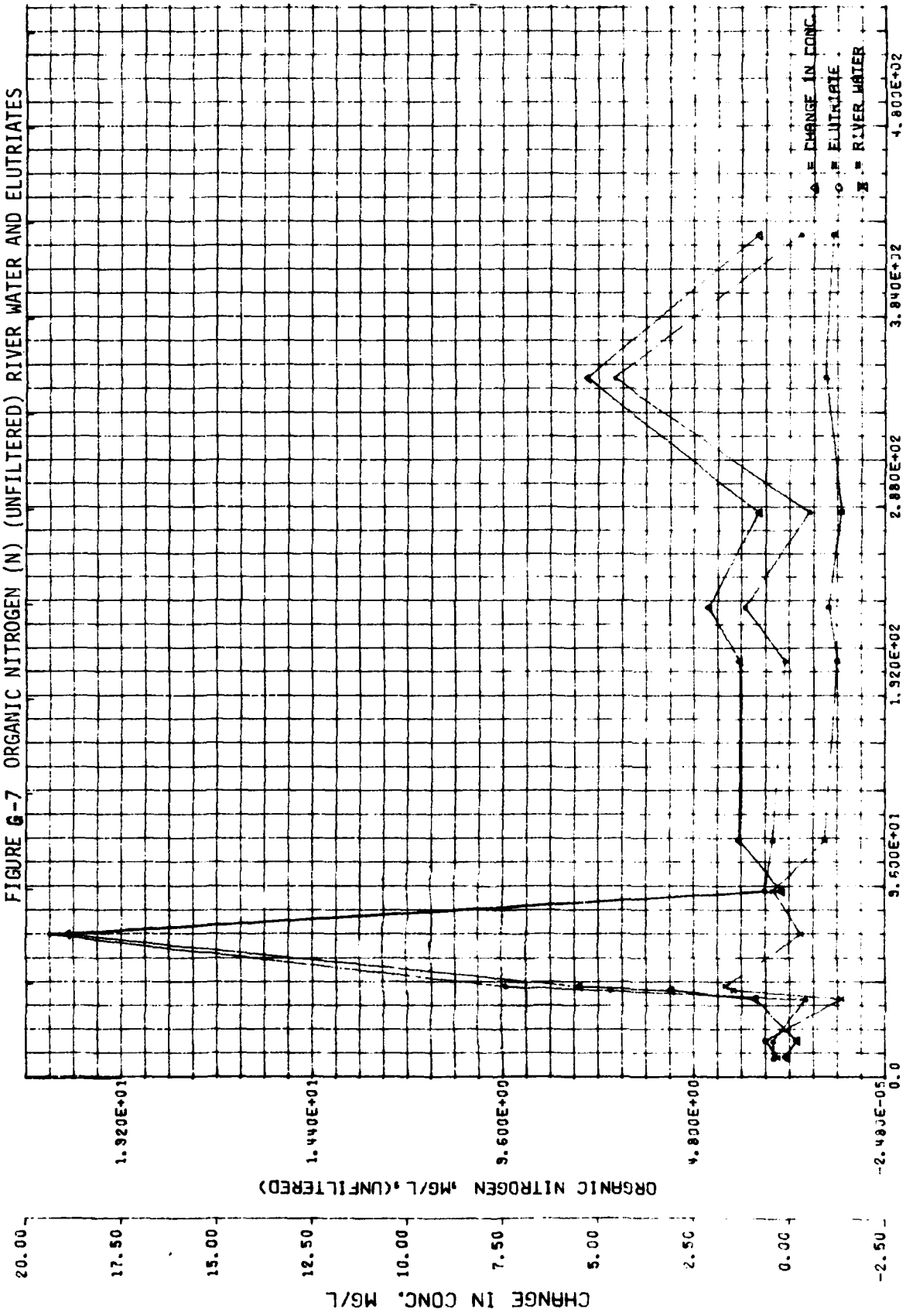


FIGURE G-7 ORGANIC NITROGEN (N) (UNFILTERED) RIVER WATER AND ELUTRIATES
CHANGE IN CONC. MG/L
ORGANIC NITROGEN, MG/L, (UNFILTERED)
CORPS RIVER MILE (0.0 = CRM 550.0)
= CHANGE IN CONC.
= ELUTRIATE
= RIVER WATER
20.00
17.50
15.00
12.50
10.00
7.50
5.00
2.50
0.00
-2.50
1.920E+01
1.440E+01
9.600E+00
4.800E+00
-2.480E-05
0.0
9.600E+01
1.920E+02
2.880E+02
3.840E+02
4.800E+02

FIGURE G-8 ORGANIC NITROGEN (N) (FILTERED) RIVER WATER AND ELUTRIATES

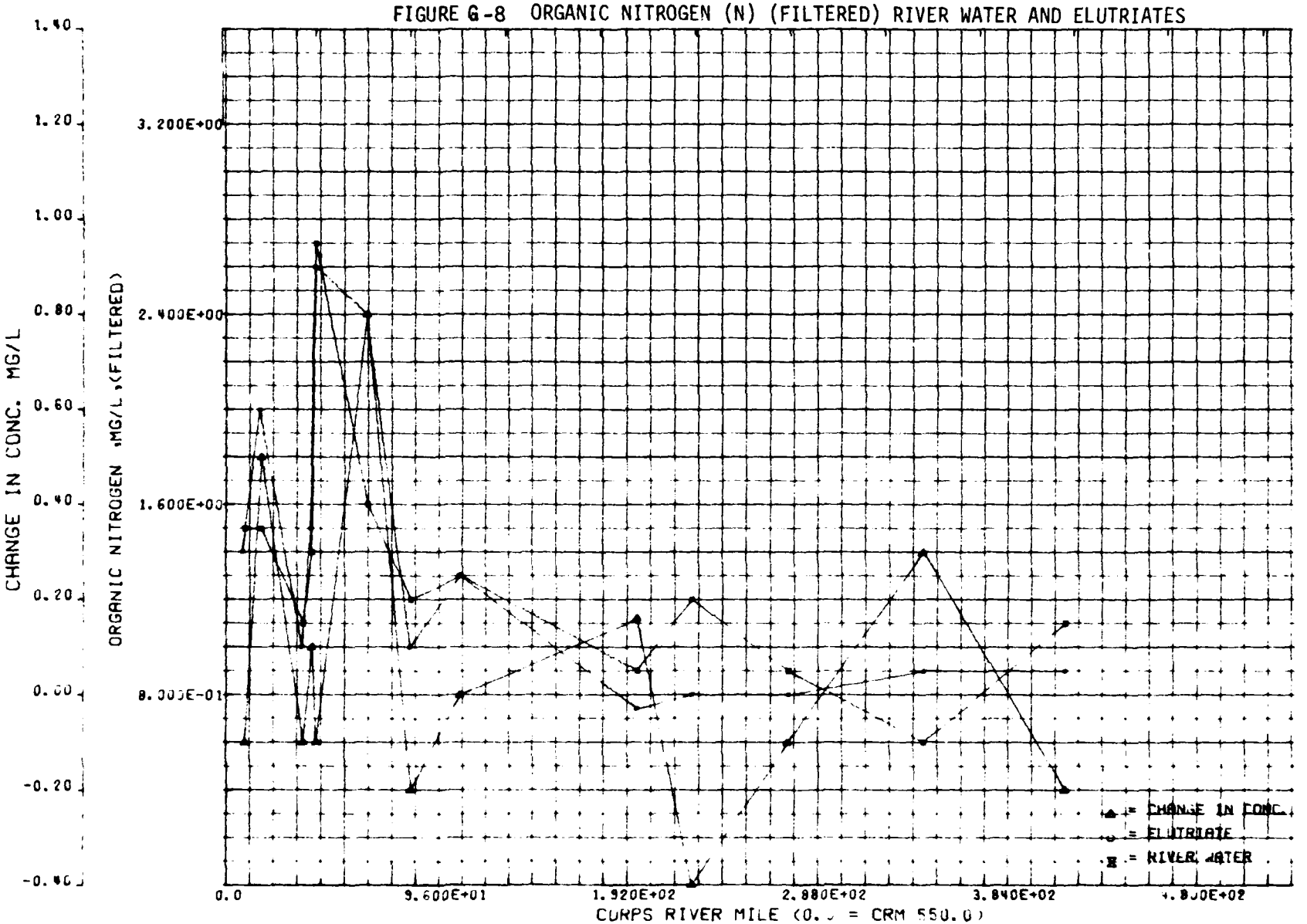


FIGURE G-9 TOTAL KJELDAHL NITROGEN (N) (UNFILTERED) RIVER WATER AND ELUTRIATES

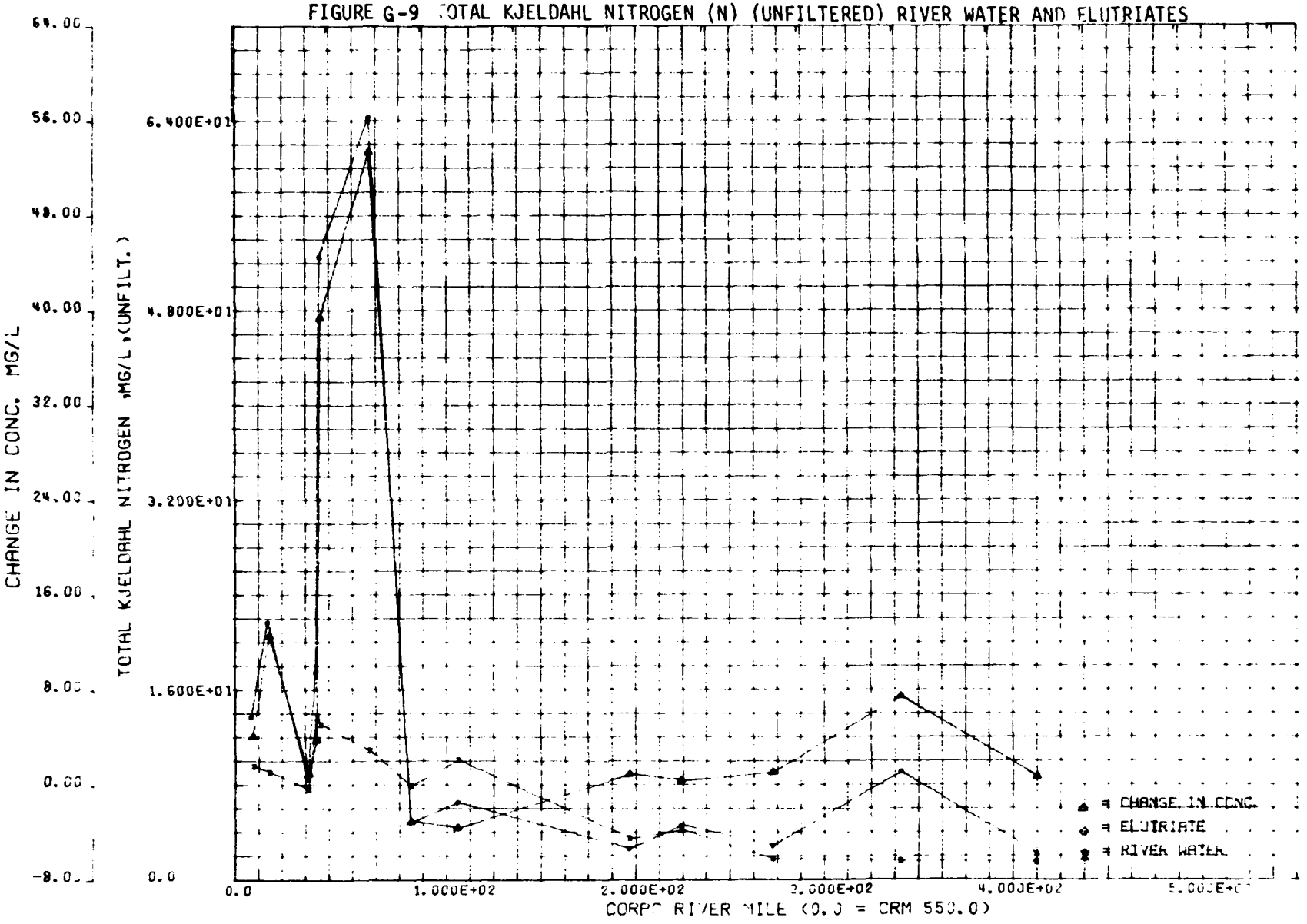


FIGURE G-10 TOTAL KJELDAHL NITROGEN (N) (FILTERED) RIVER WATER AND ELUTRIATES

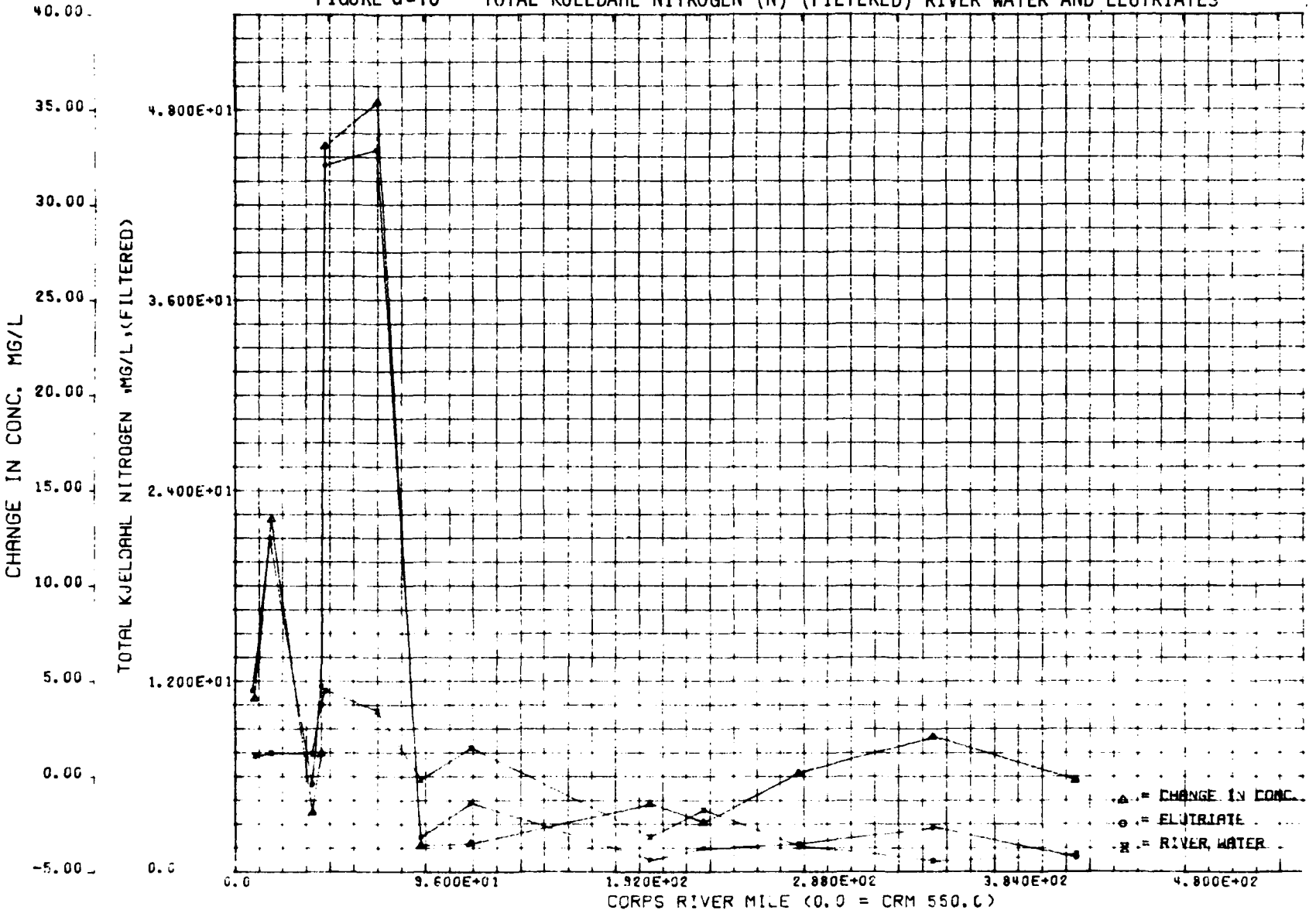


FIGURE G-11 TOTAL PHOSPHORUS (UNFILTERED) RIVER WATER AND ELUTRIATES

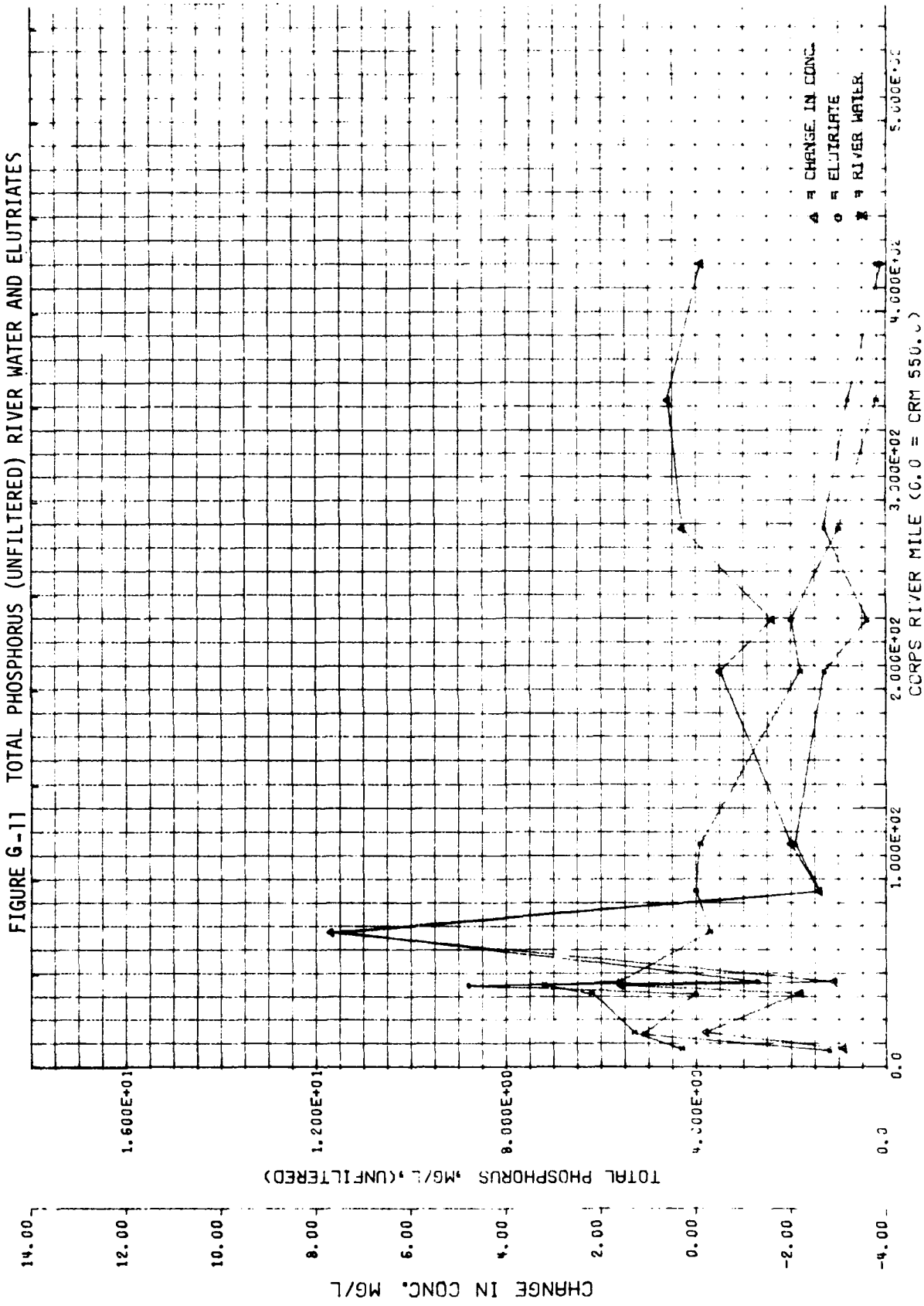


FIGURE G-12 TOTAL PHOSPHORUS (FILTERED) RIVER WATER AND ELUTRIATES

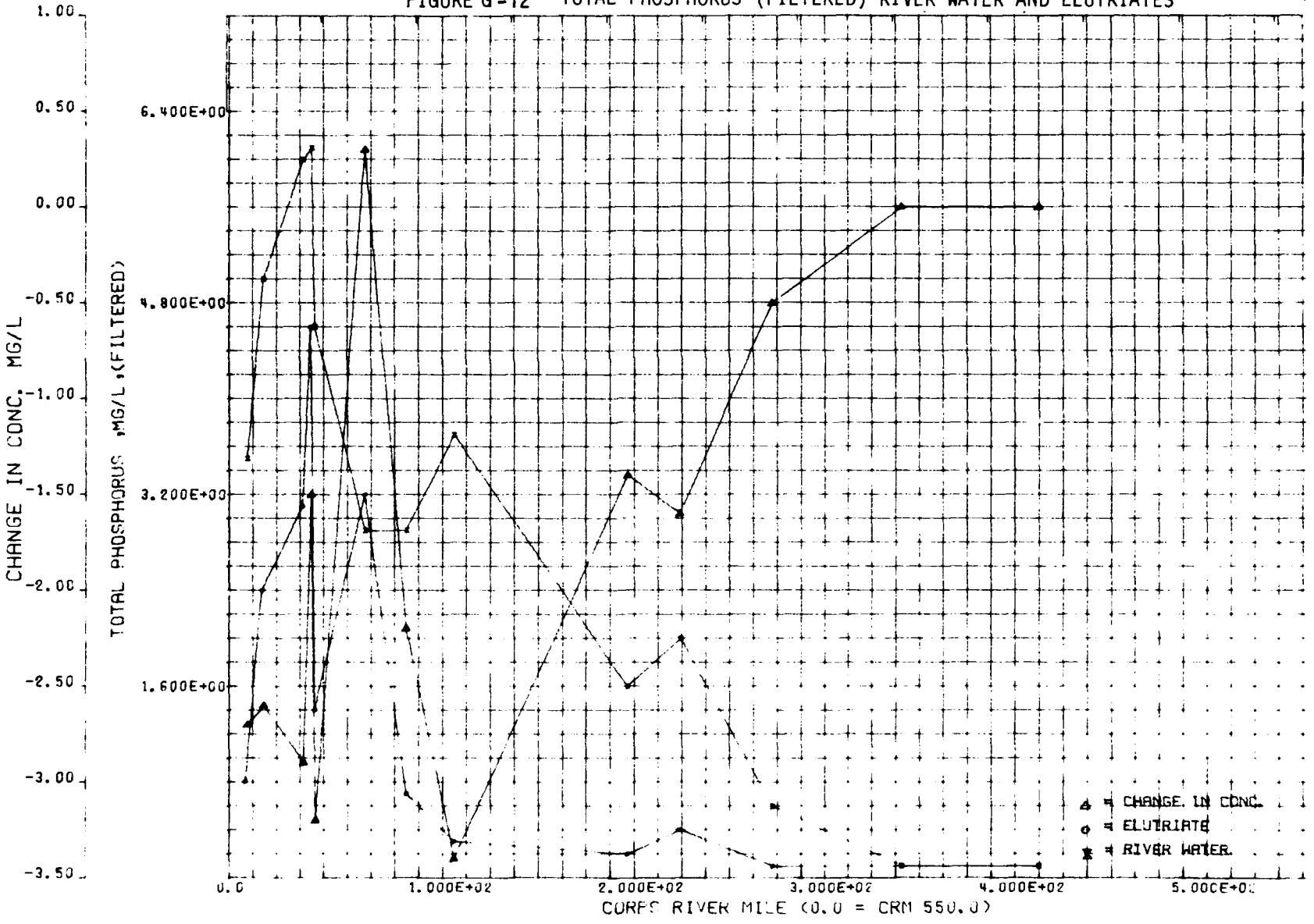


FIGURE G-13 TOTAL ORGANIC CARBON (UNFILTERED) RIVER WATER AND ELUTRIATES

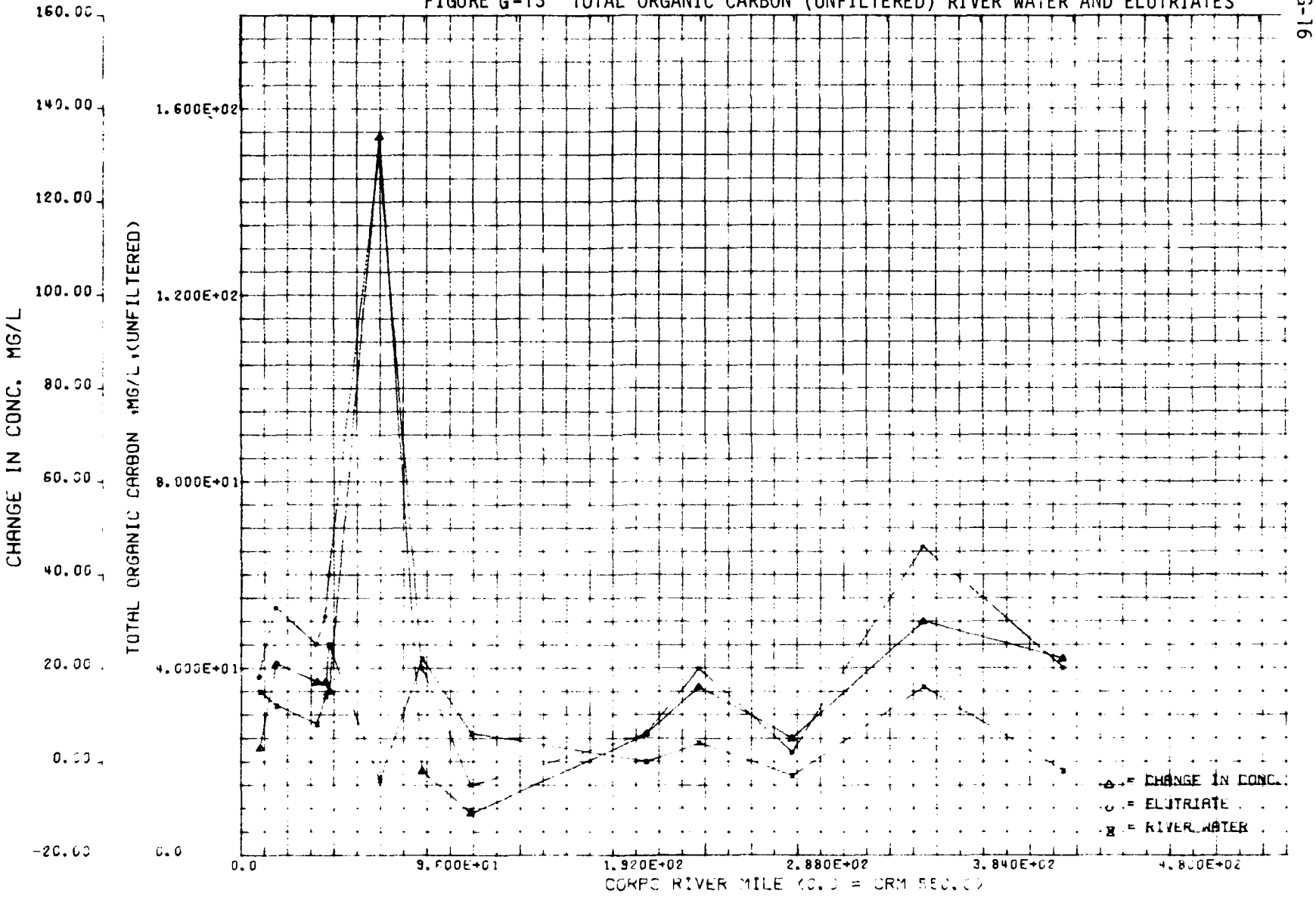


FIGURE G-14 TOTAL ORGANIC CARBON (FILTERED) RIVER WATER AND ELUTRIATES

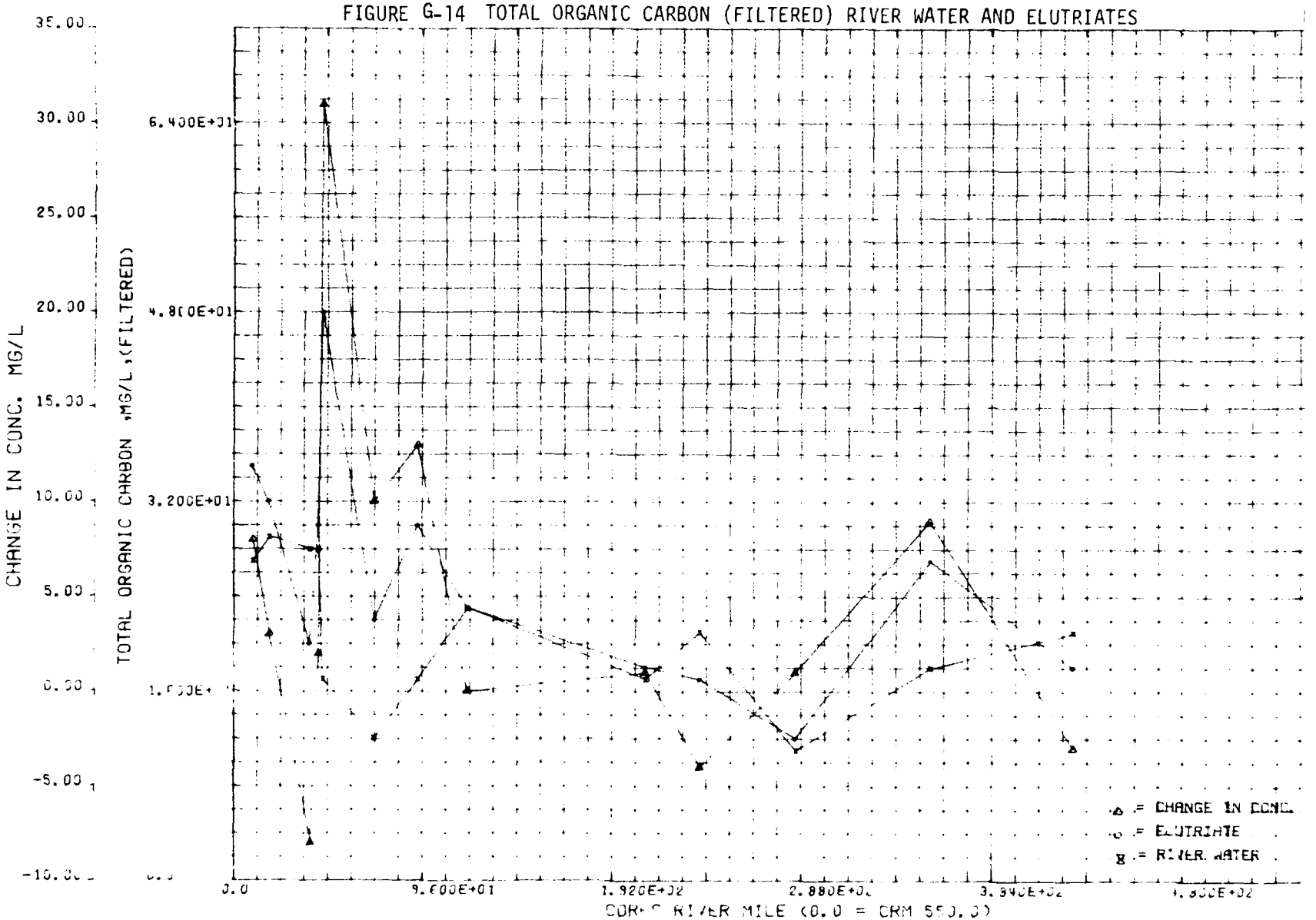


FIGURE G-15 TOTAL CARBON (UNFILTERED) RIVER WATER AND ELUTRIATES

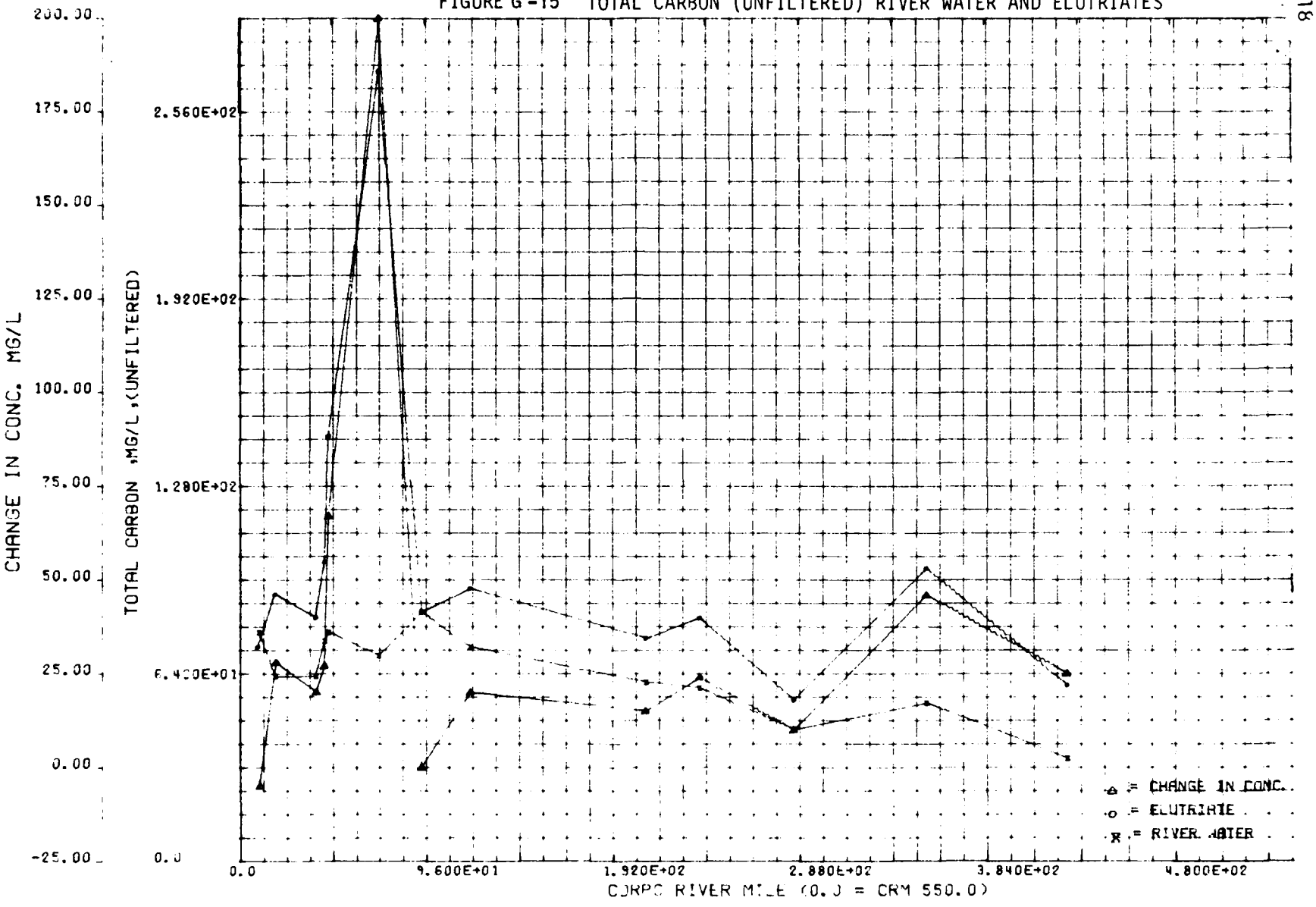
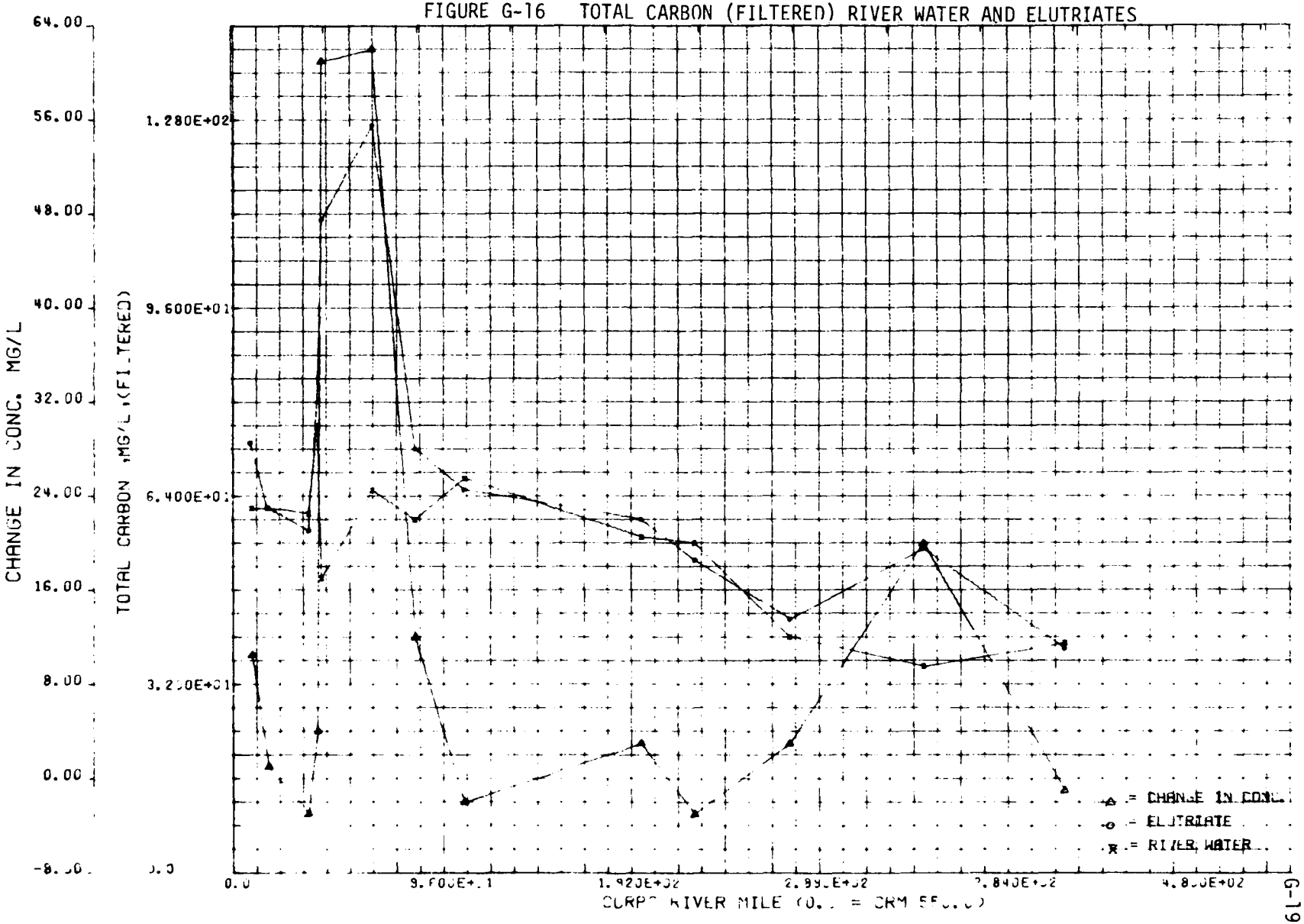


FIGURE G-16 TOTAL CARBON (FILTERED) RIVER WATER AND ELUTRIATES



APPENDIX H

GRAPHICAL REPRESENTATION OF RESULTS
OF VARIOUS PARAMETERS IN
BOTTOM SEDIMENTS

GRAPHICAL REPRESENTATION OF RESULTS OF VARIOUS PARAMETERS IN BOTTOM SEDIMENTS

(See Appendix G (pages G-1, G-2, G-3) for interpretation of plots)

TABLE OF CONTENTS

Figure and Number and Description

FIGURE H -1 VOLATILE SOLIDS (SEDIMENT)

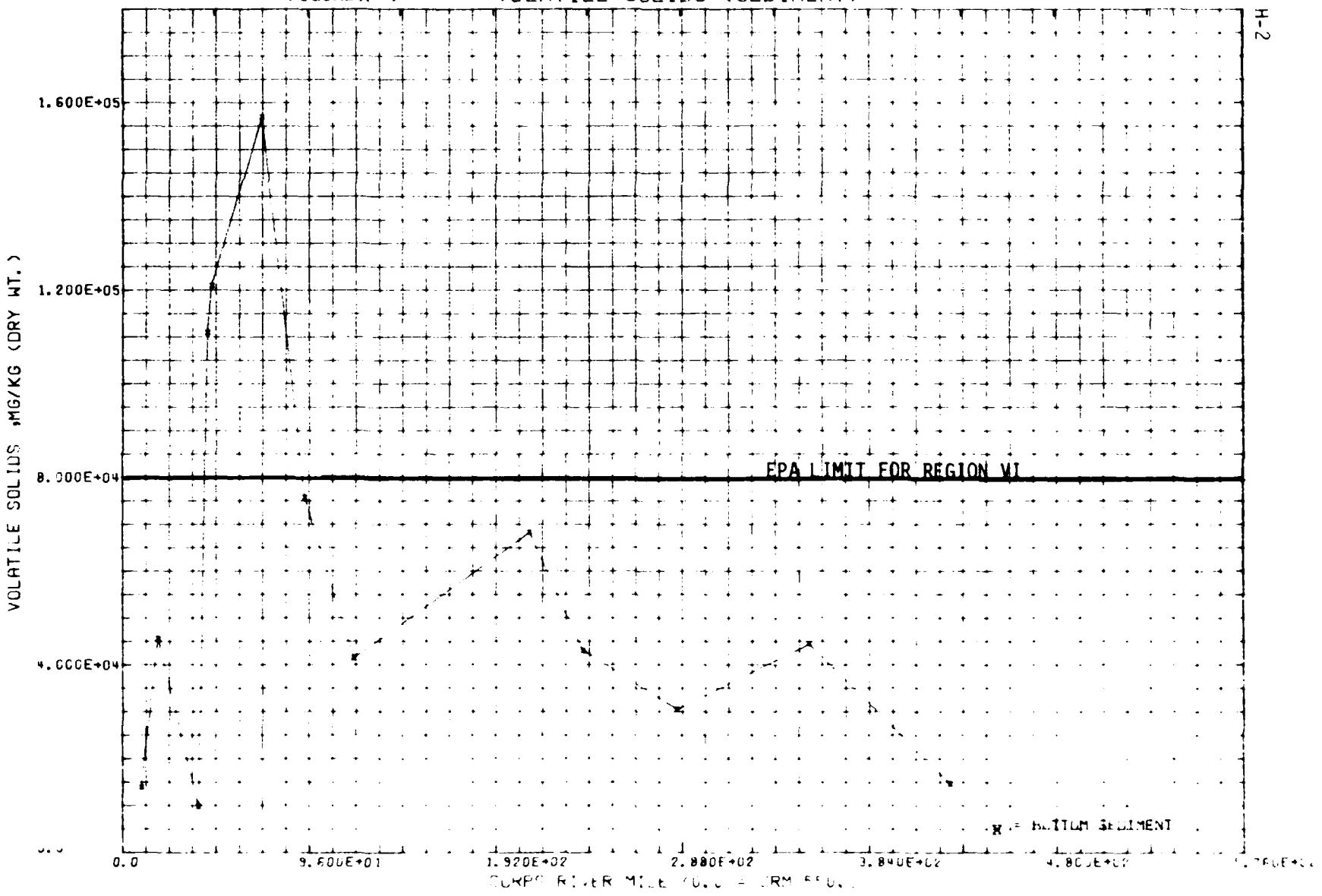


FIGURE H-2

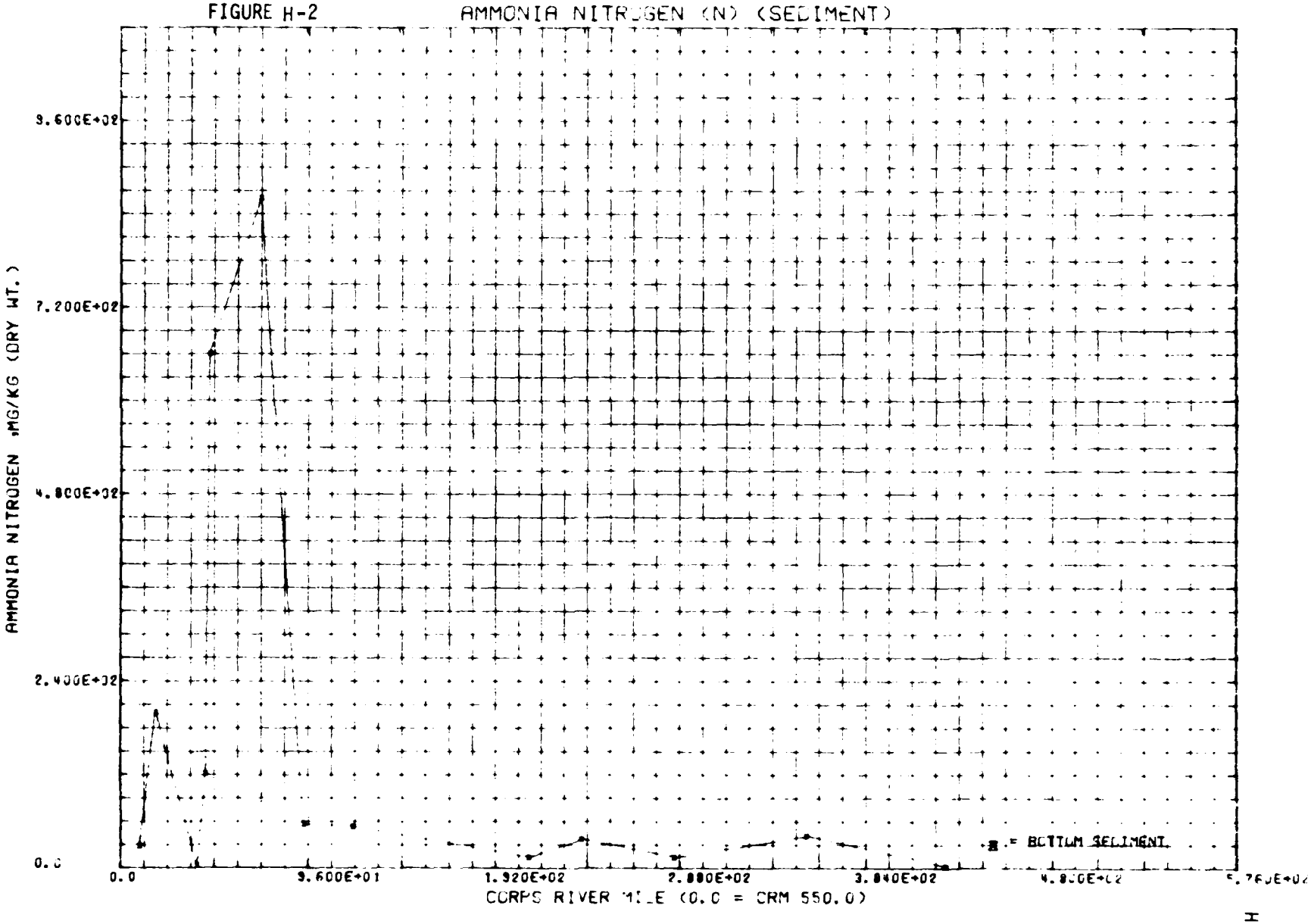

AMMONIA NITROGEN (N) (SEDIMENT)
AMMONIA NITROGEN (MG/KG (DRY WT.)
9.600E+02
7.200E+02
4.800E+02
2.400E+02
0.0
0.0
9.600E+01
1.920E+02
2.880E+02
3.840E+02
CORPS RIVER MILE (0.0 = CRM 550.0)
= BOTTOM SEDIMENT

FIGURE H-3

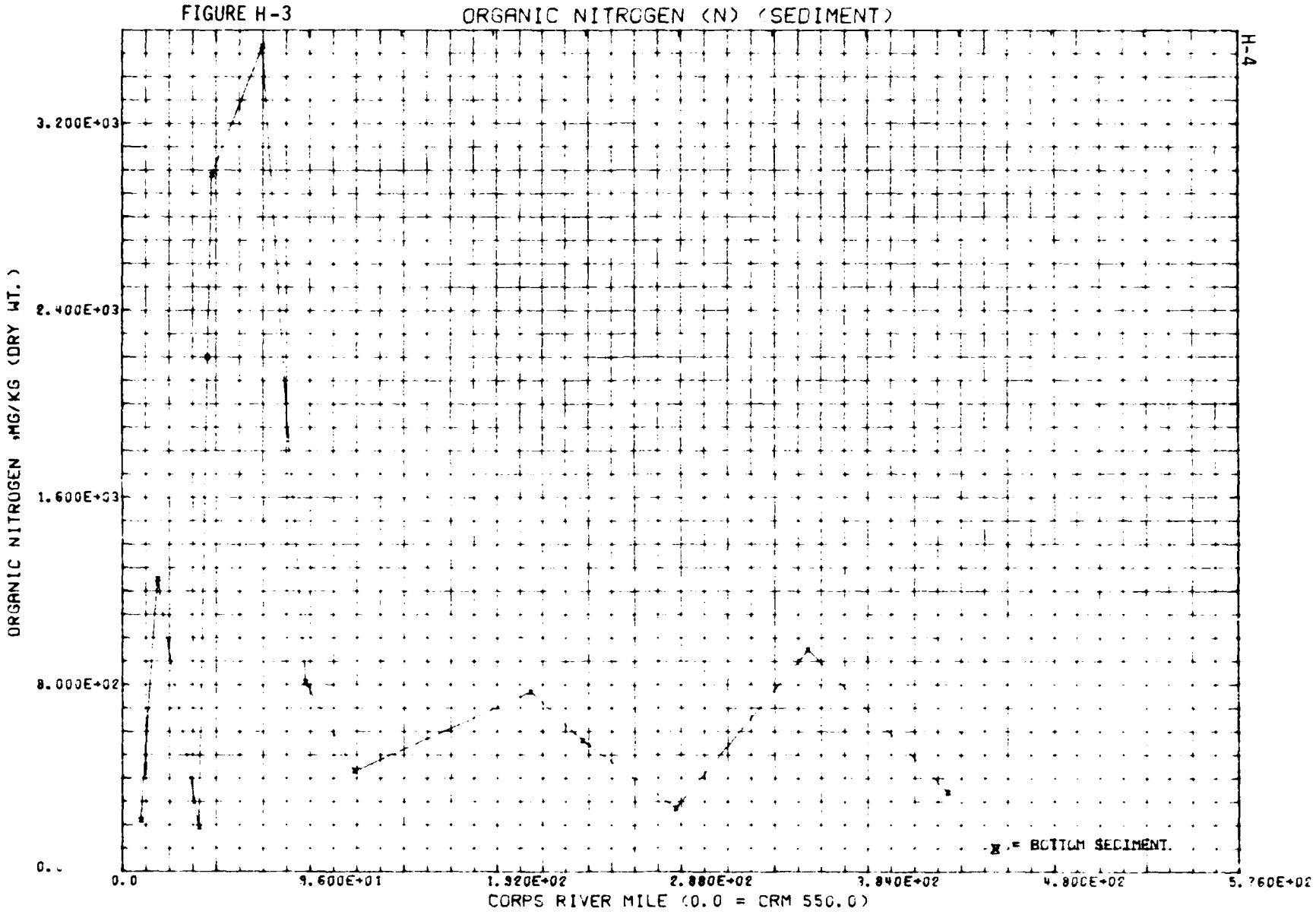

ORGANIC NITROGEN (N) (SEDIMENT)
H-4
ORGANIC NITROGEN ,MG/KG (DRY WT.)
3.200E+03
2.400E+03
1.600E+03
8.000E+02
0.0
0.0
9.600E+01
1.920E+02
2.880E+02
3.840E+02
4.800E+02
5.760E+02
CORPS RIVER MILE (0.0 = CRM 550.0)
= BOTTOM SEDIMENT.

FIGURE H-4 TOTAL KJELDAHL NITROGEN (N) (SEDIMENT)

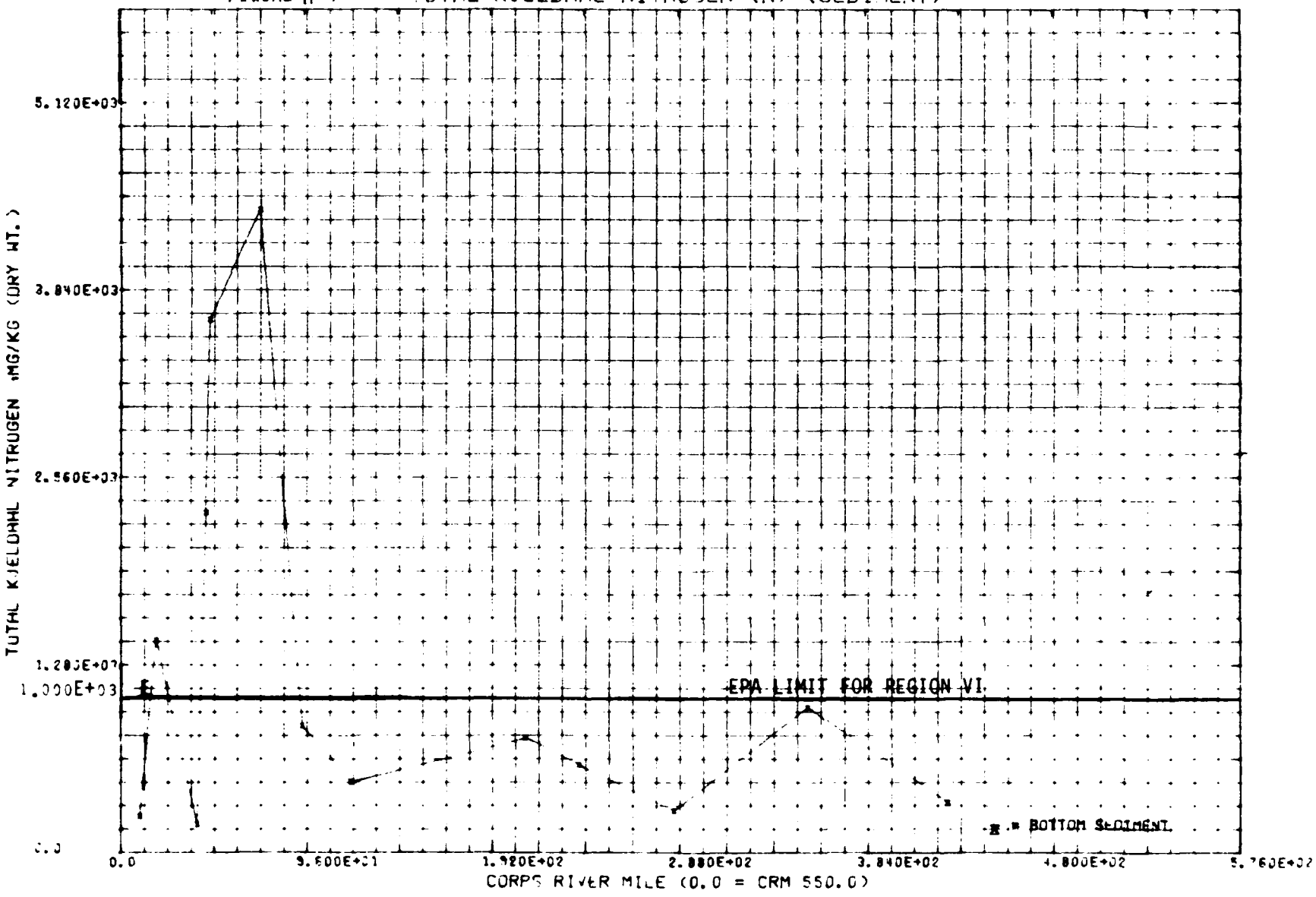


FIGURE H-5 TOTAL PHOSPHORUS (P) (SEDIMENT)

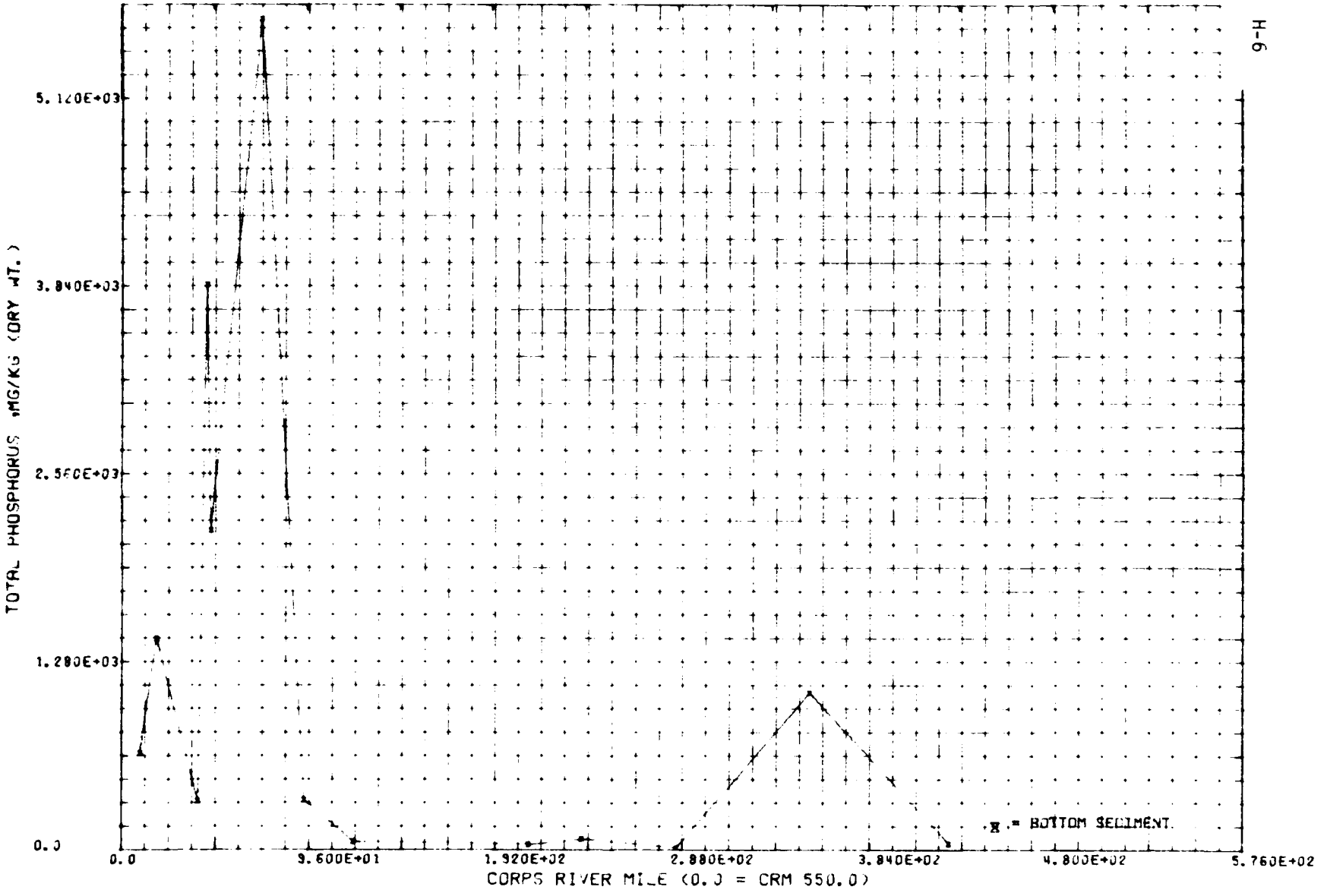


FIGURE H-6 CHEMICAL OXYGEN DEMAND (SEDIMENT)

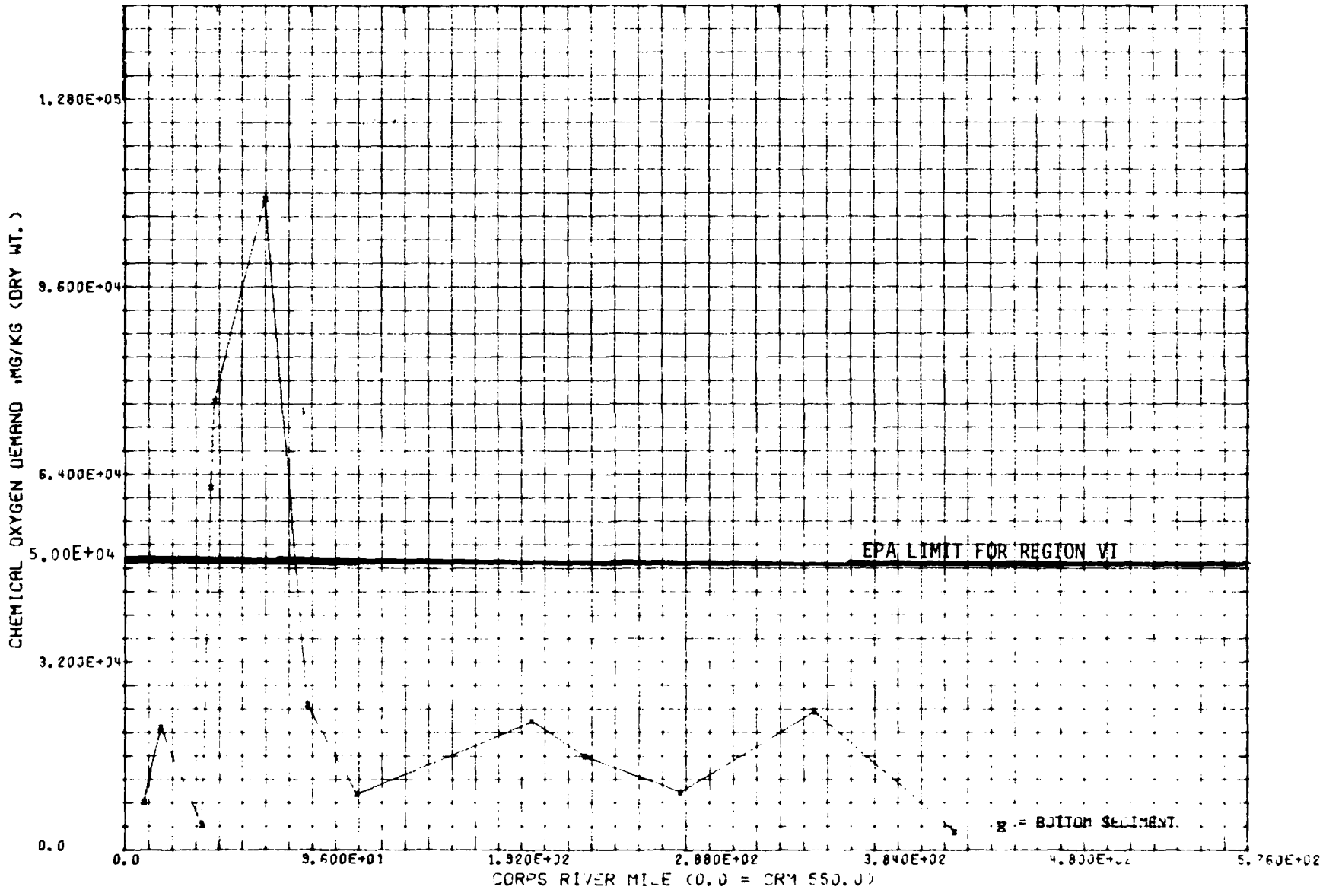


FIGURE H-7 TOTAL ORGANIC CARBON (SEDIMENT)

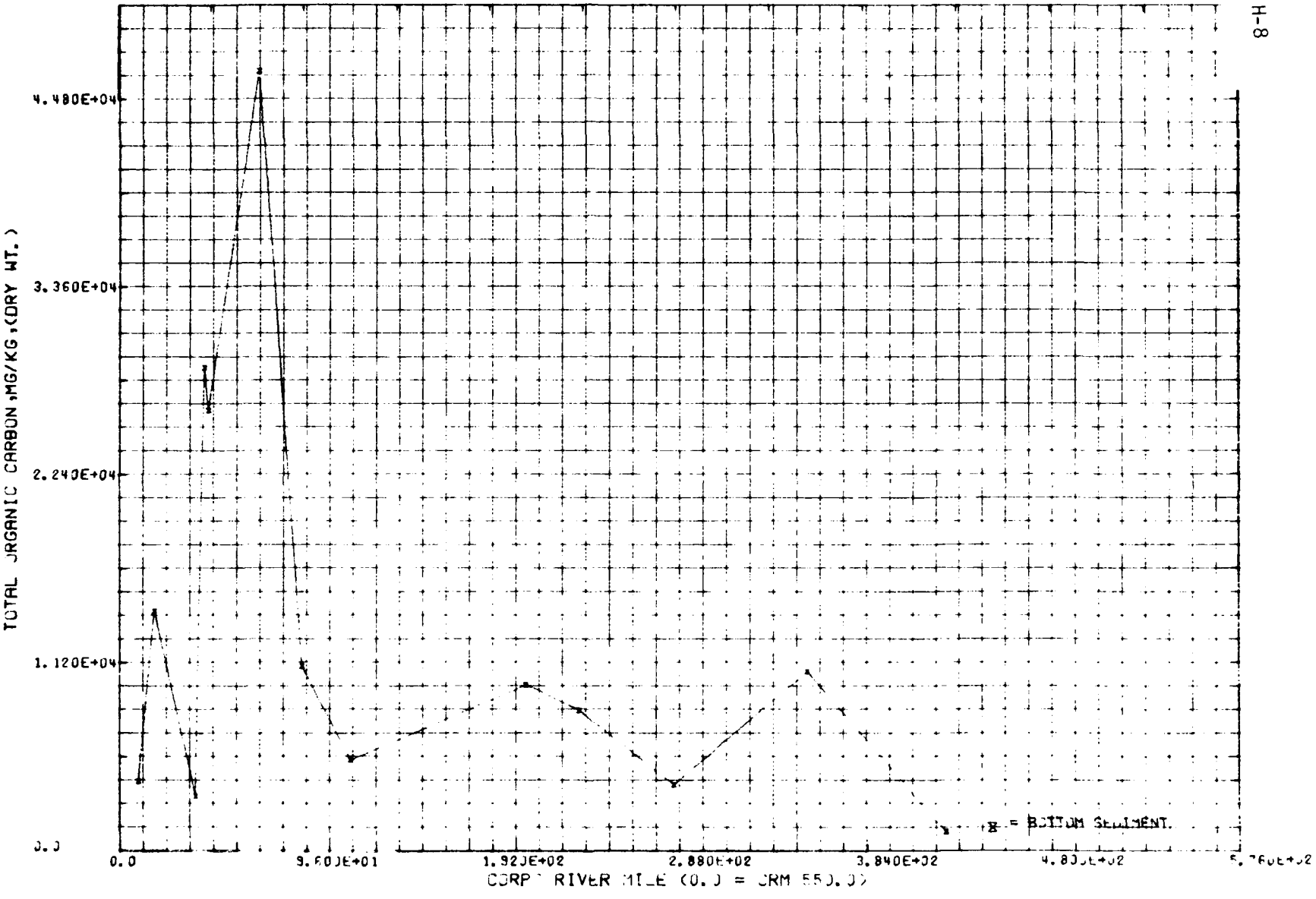
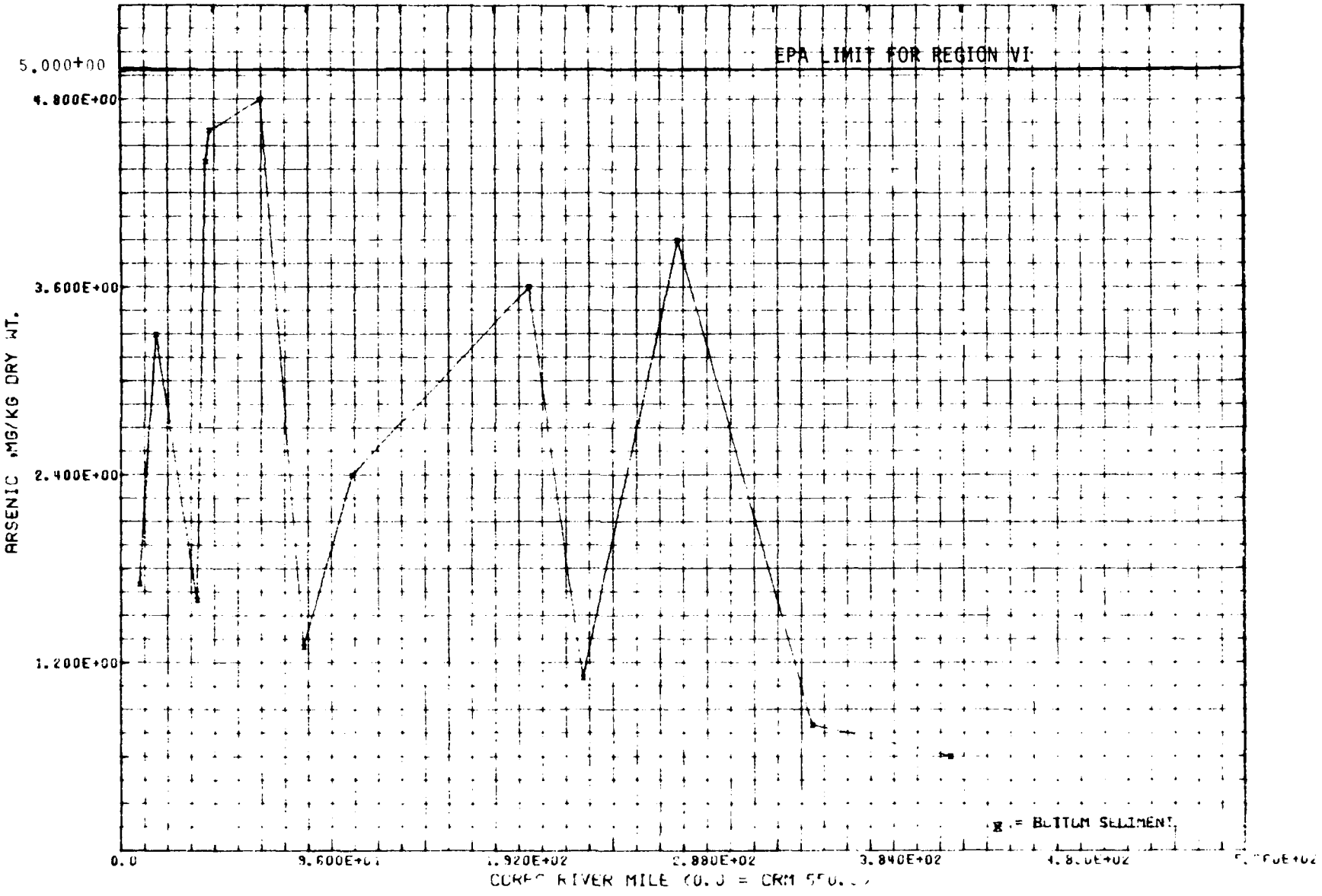


FIGURE H-8 ARSENIC (SEDIMENT)



CORPS RIVER MILE (0.0 = CRM 590.0)

FIGURE H-9 CADMIUM (SEDIMENT)

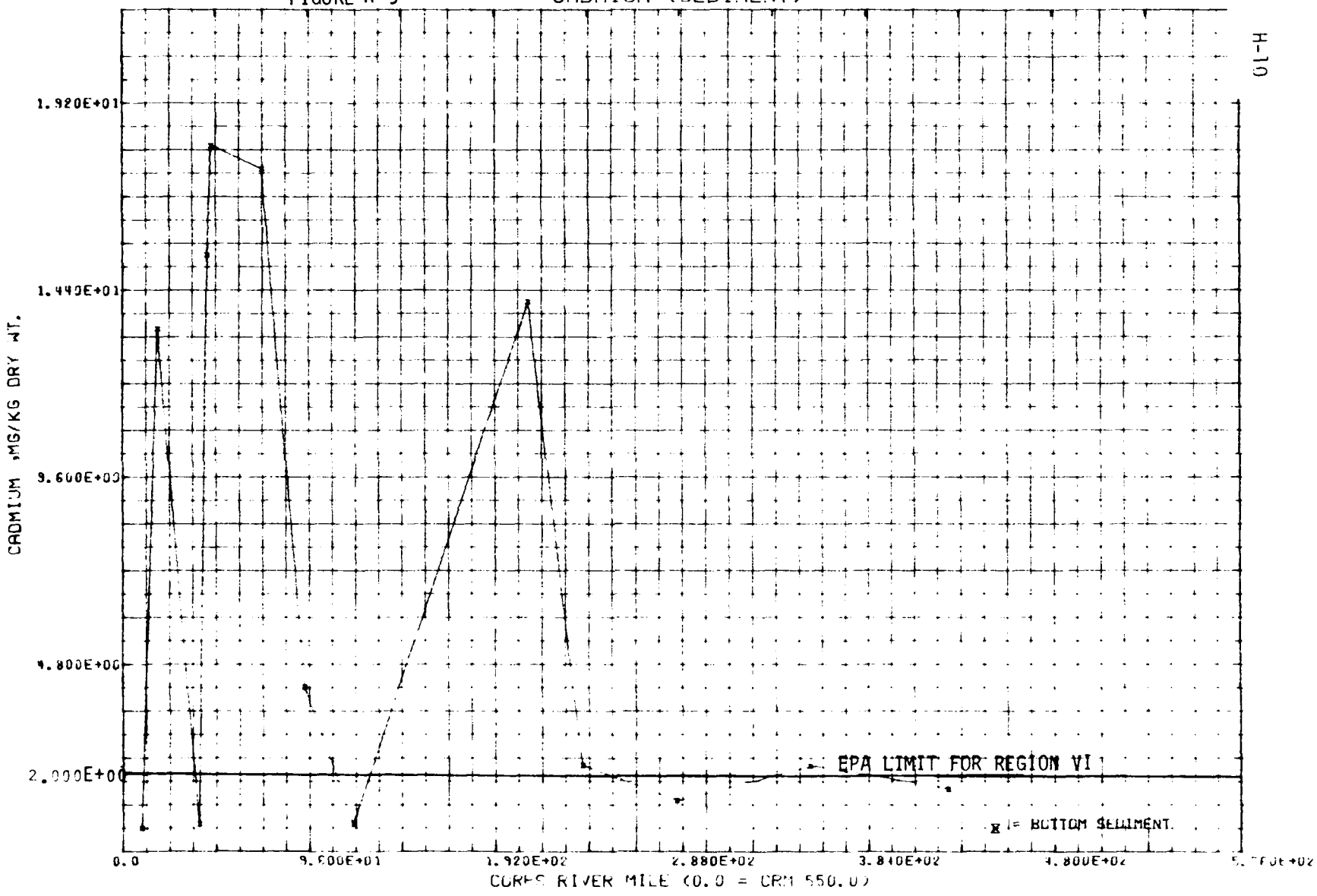


FIGURE H-10 CHROMIUM (SEDIMENT)

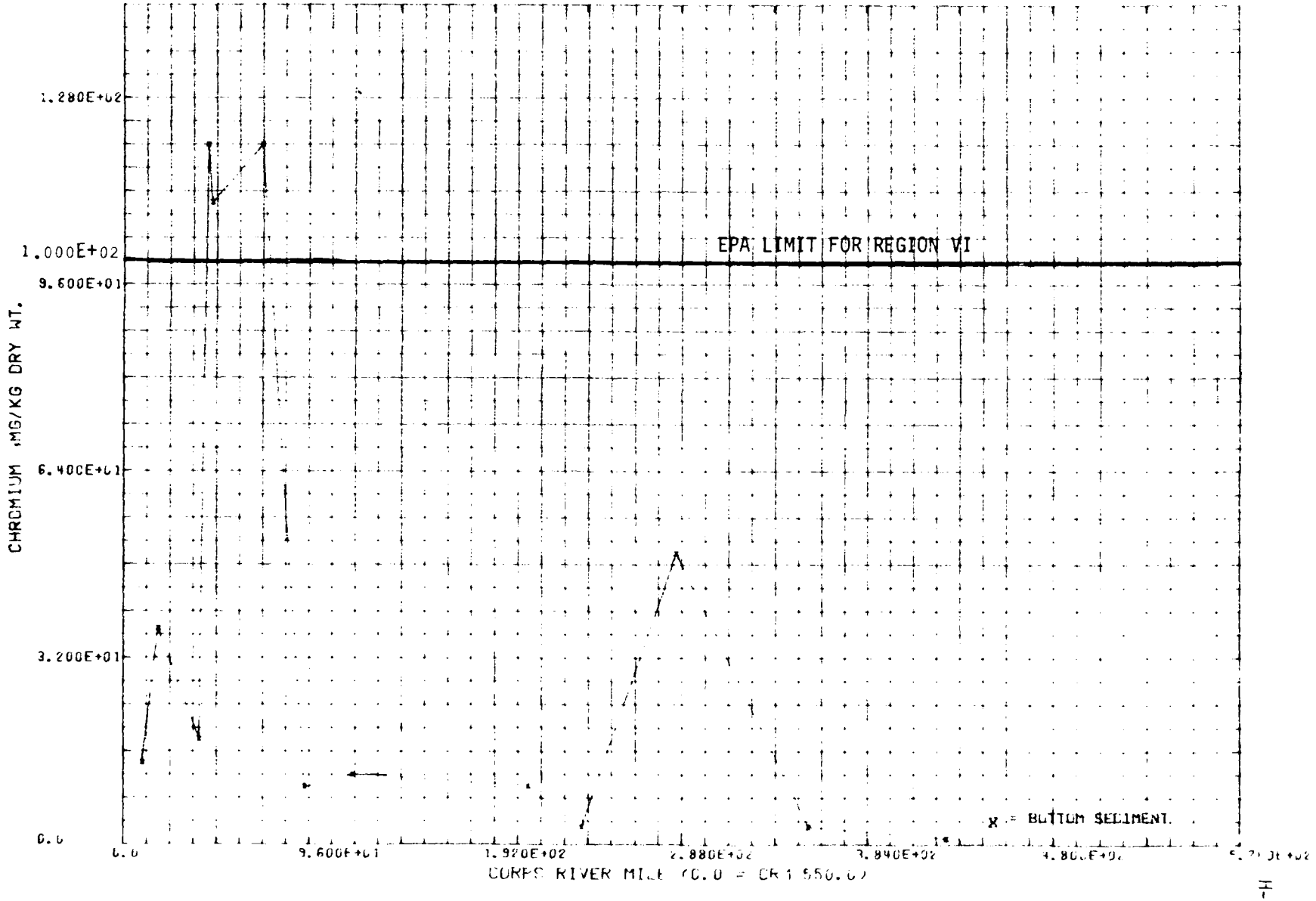


FIGURE H-11 COPPER (SEDIMENT)

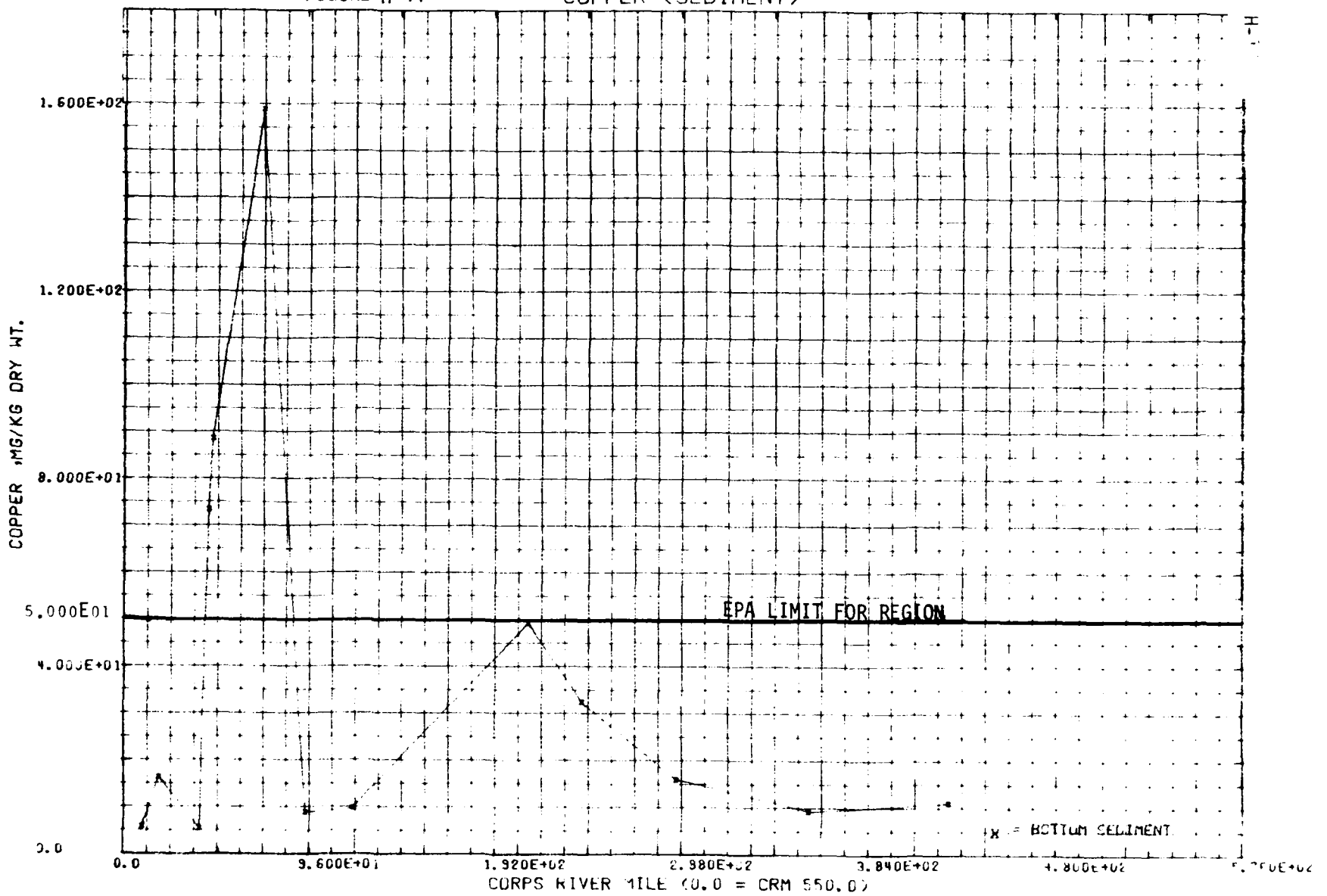


FIGURE H-12 LEAD (SEDIMENT)

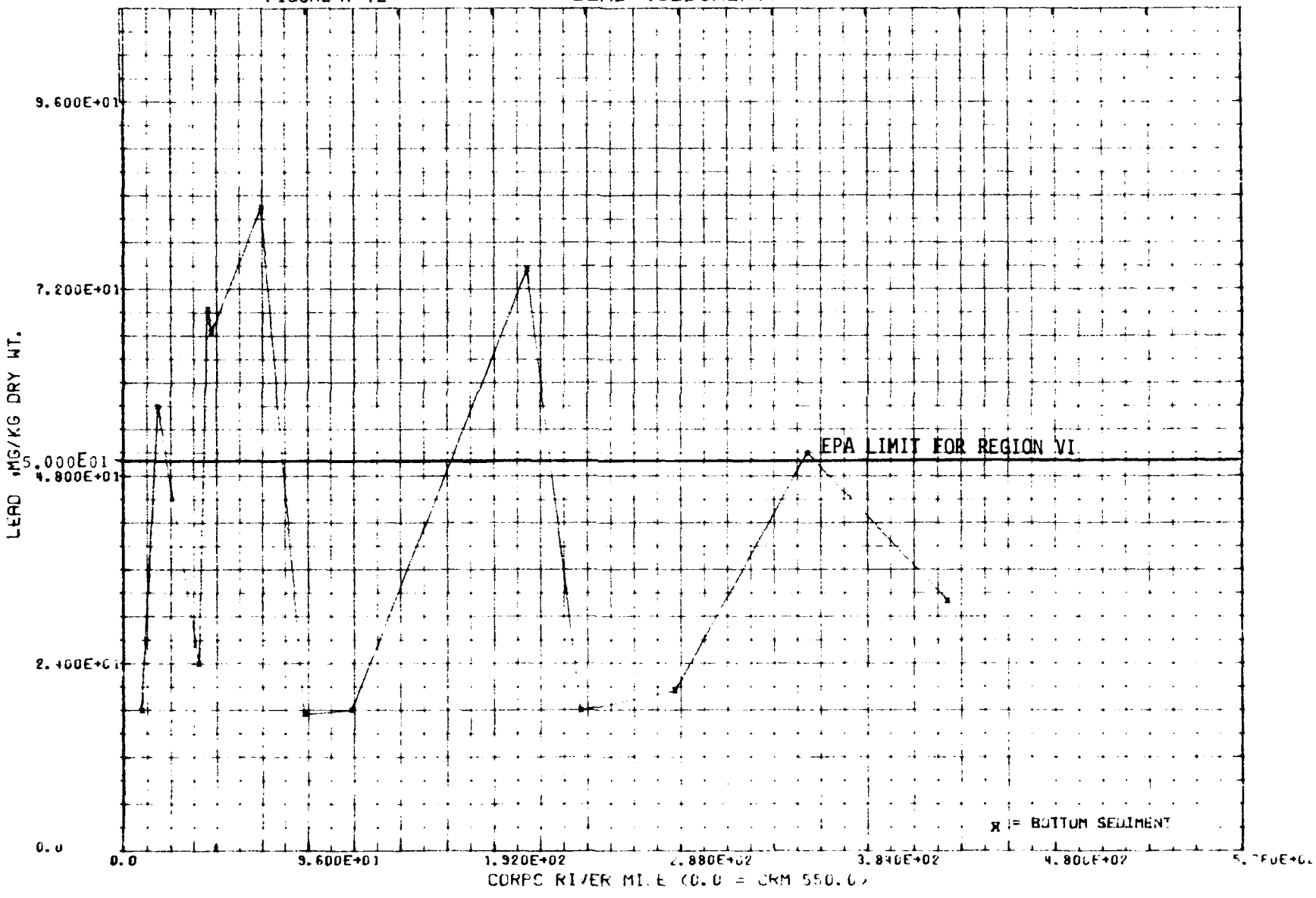


FIGURE H-13

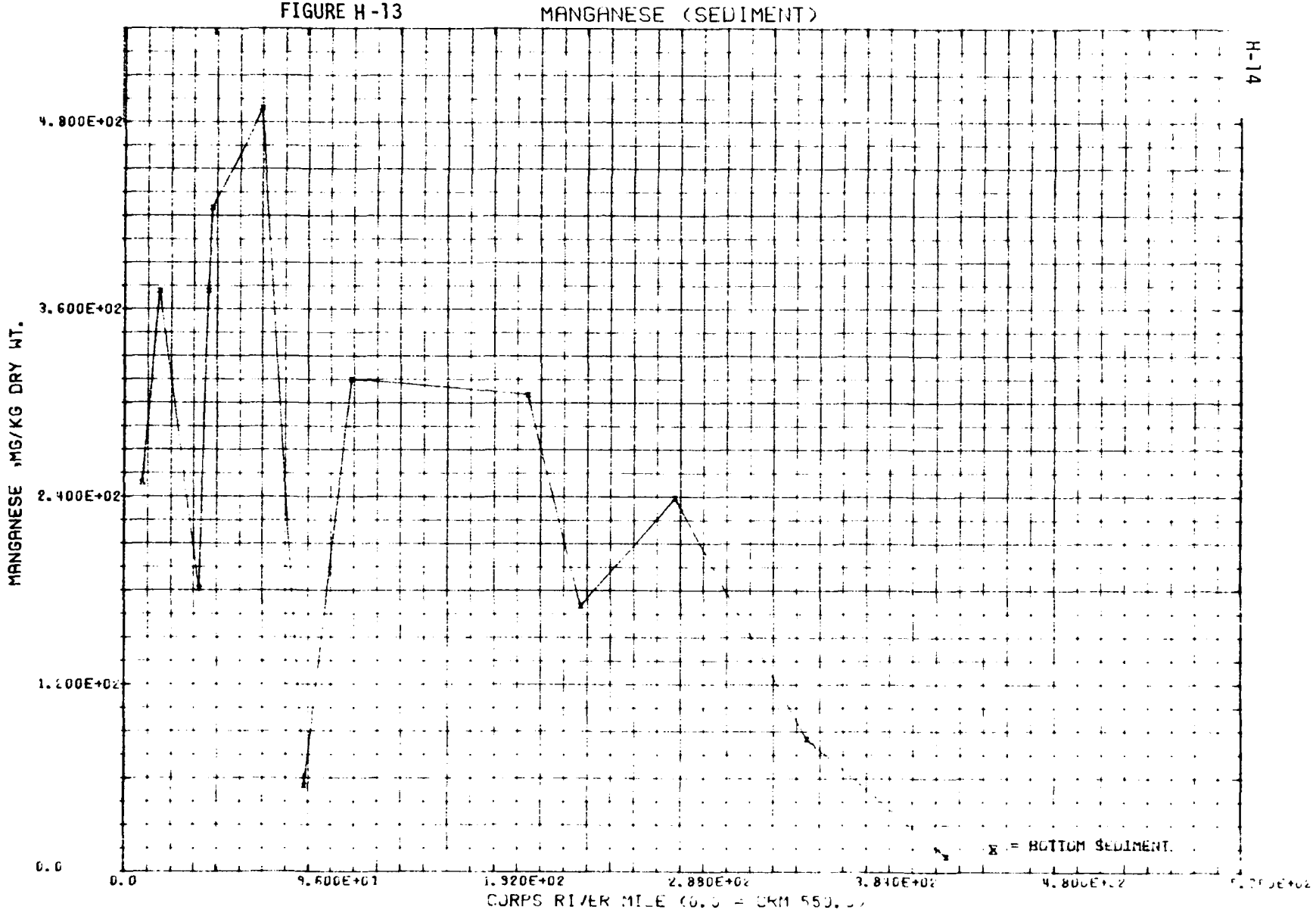

MANGANESE (SEDIMENT)
MANGANESE ,MG/KG DRY WT.
4.800E+02
3.600E+02
2.400E+02
1.200E+02
0.0
0.0
9.600E+01
1.920E+02
2.880E+02
3.840E+02
4.800E+02
X = BOTTOM SEDIMENT.
CORPS RIVER MILE

FIGURE H-14 MERCURY (SEDIMENT)

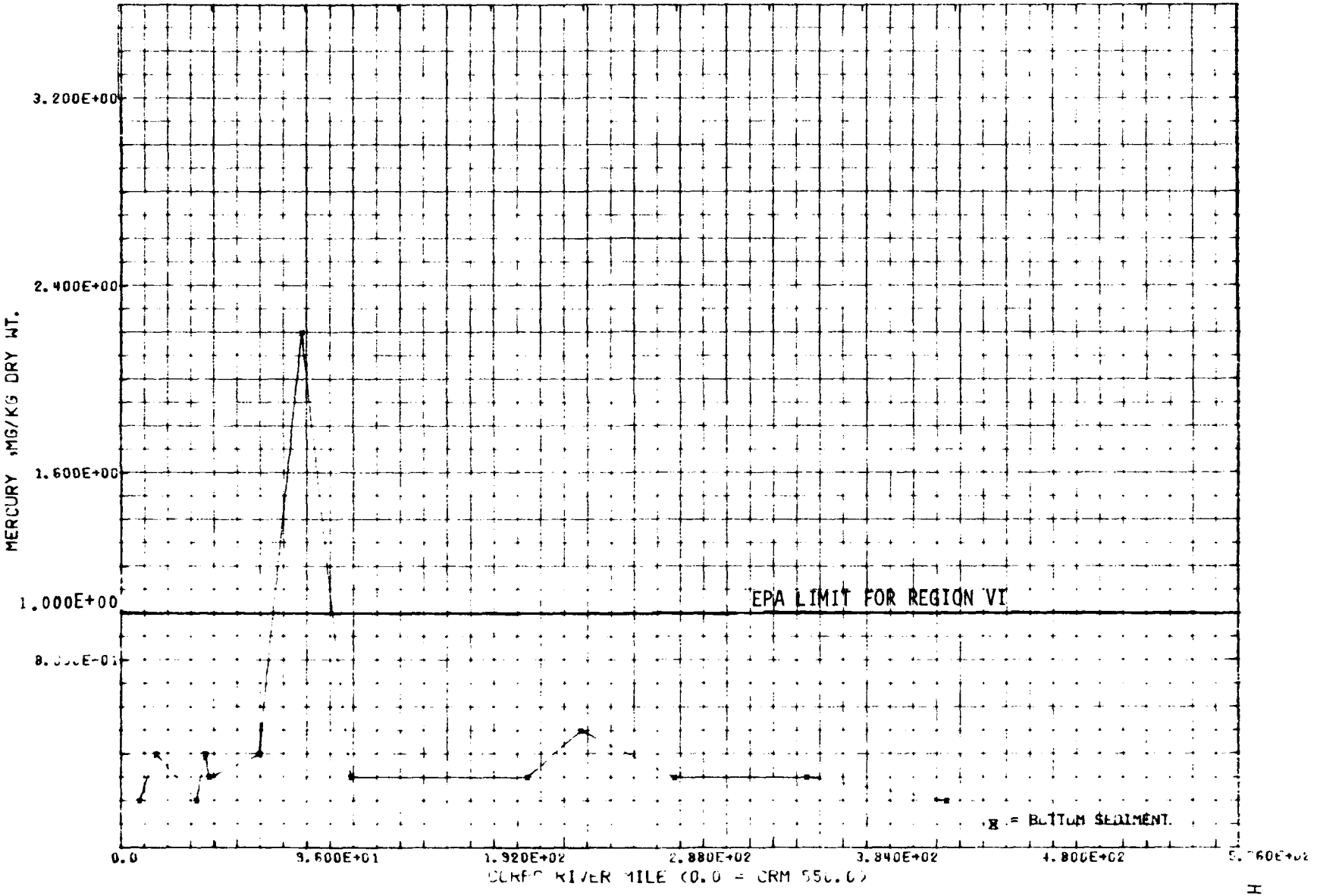


FIGURE H-15 NICKEL (SEDIMENT)

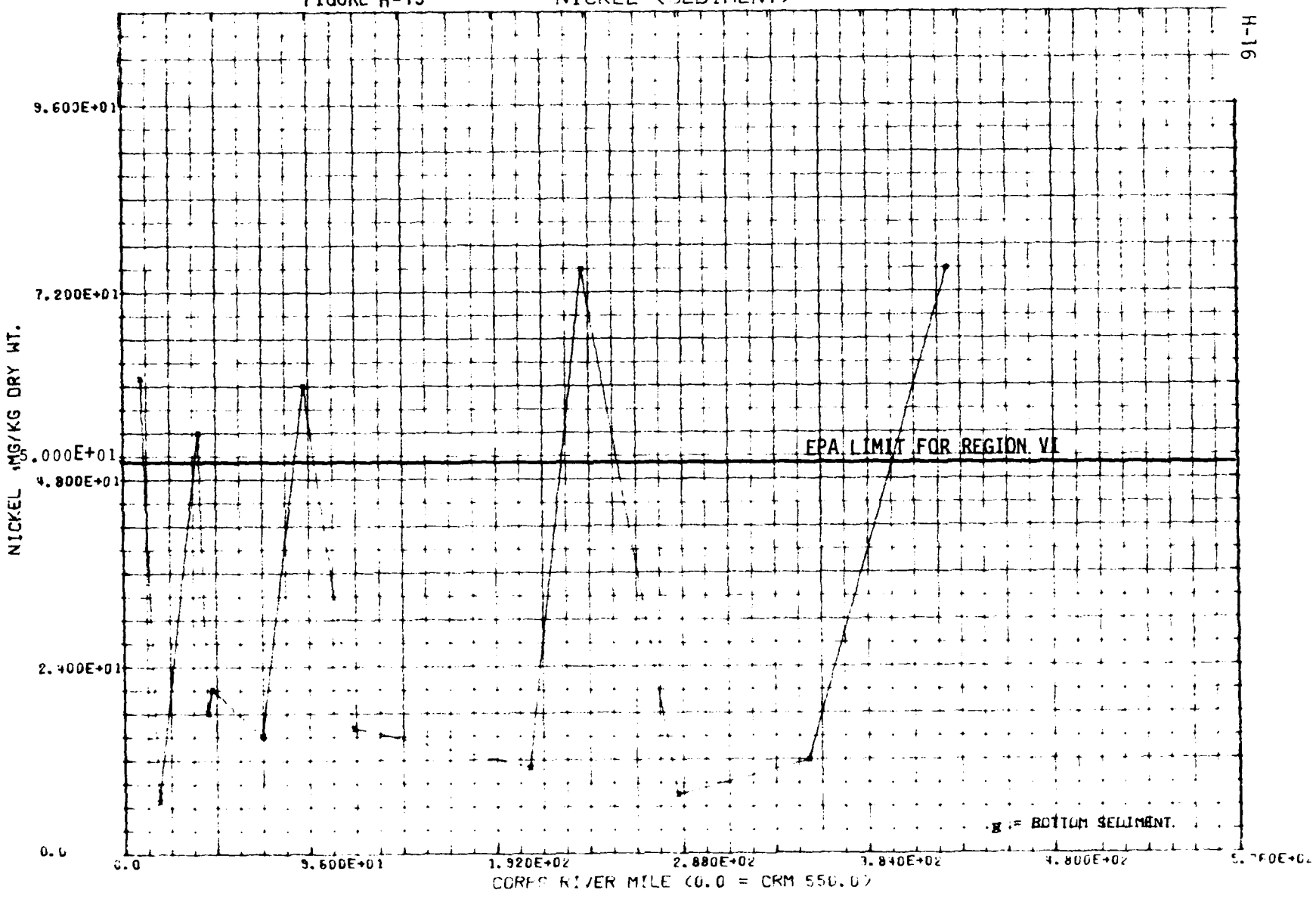


FIGURE H-16 ZINC (SEDIMENT)

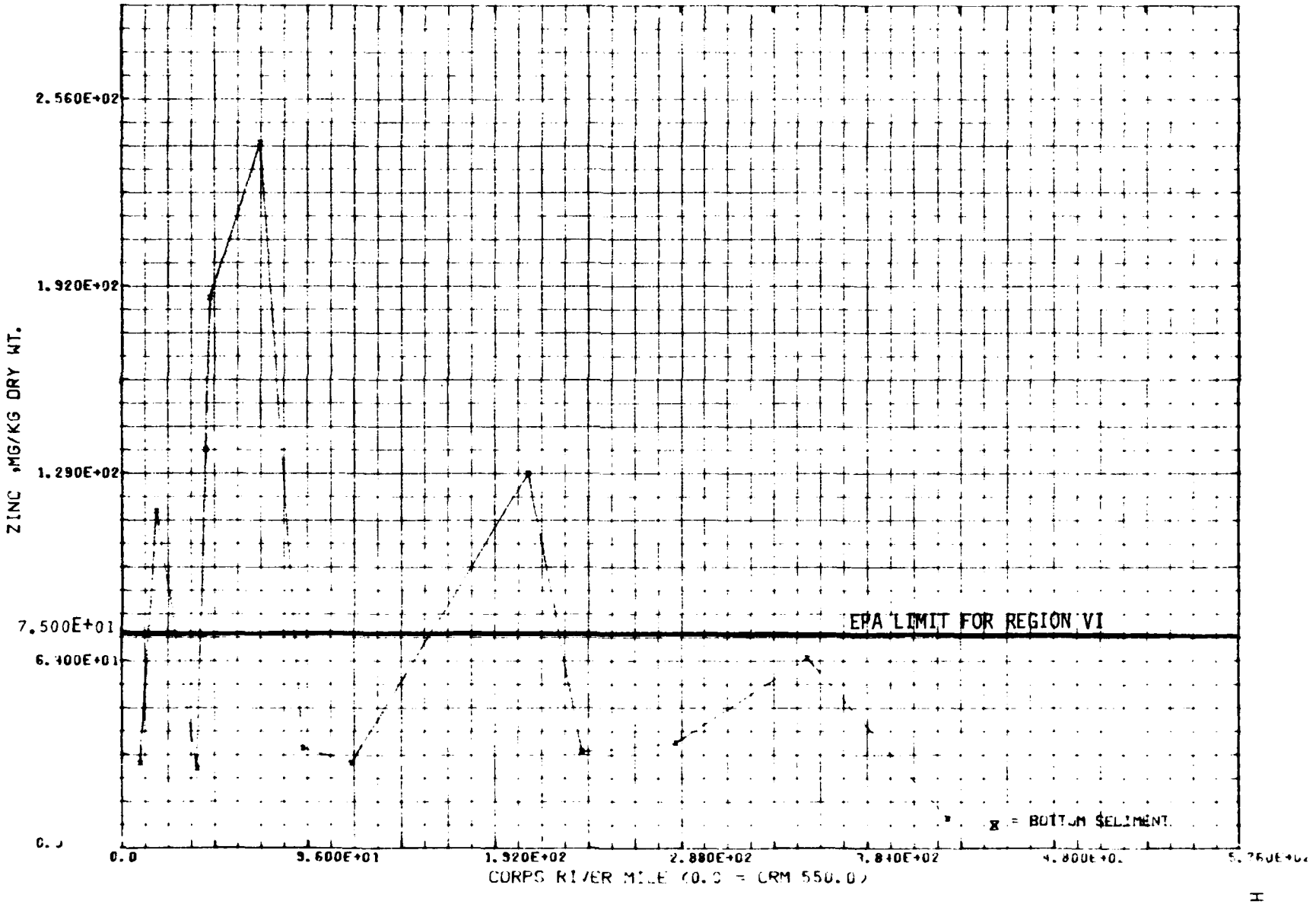
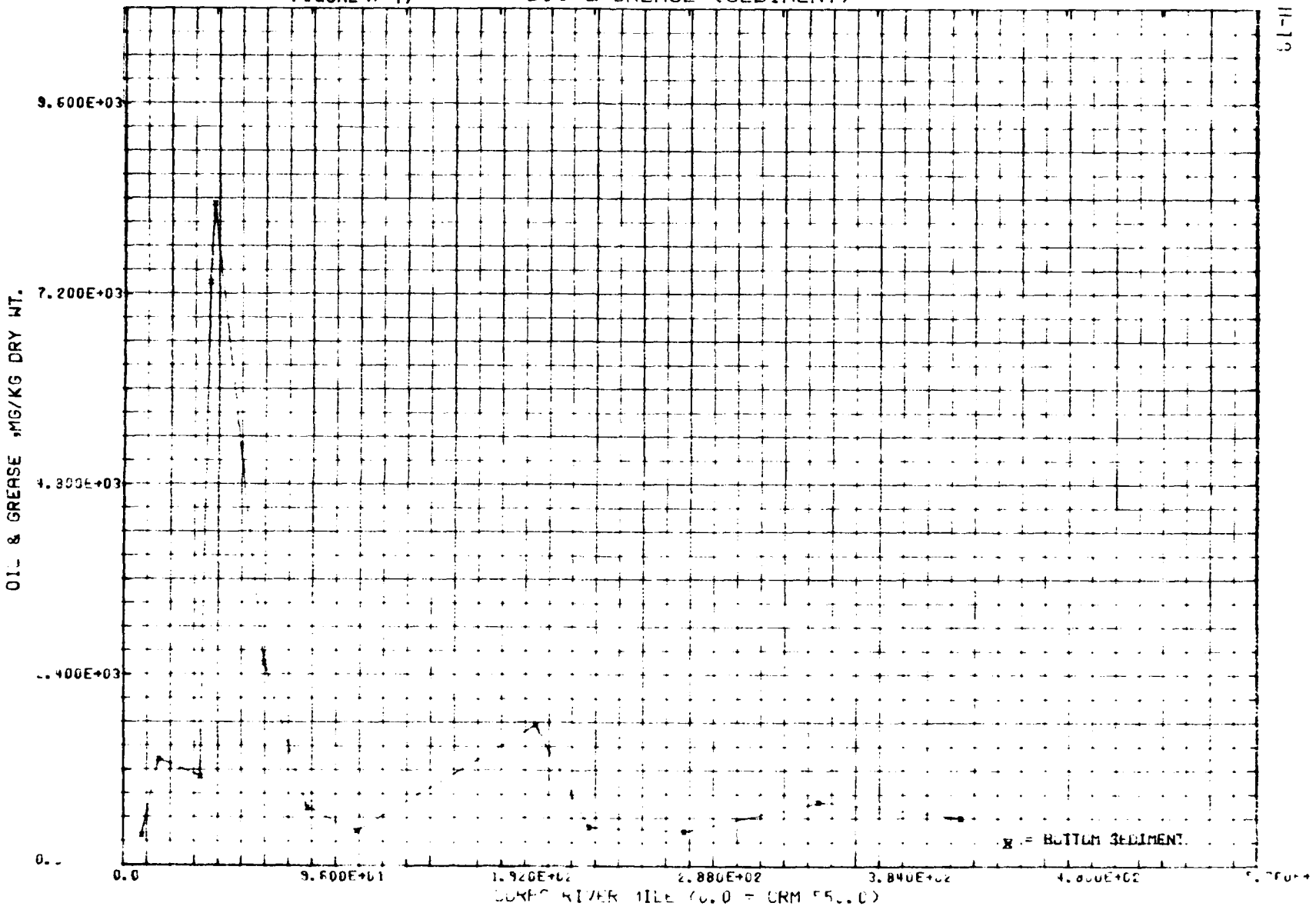
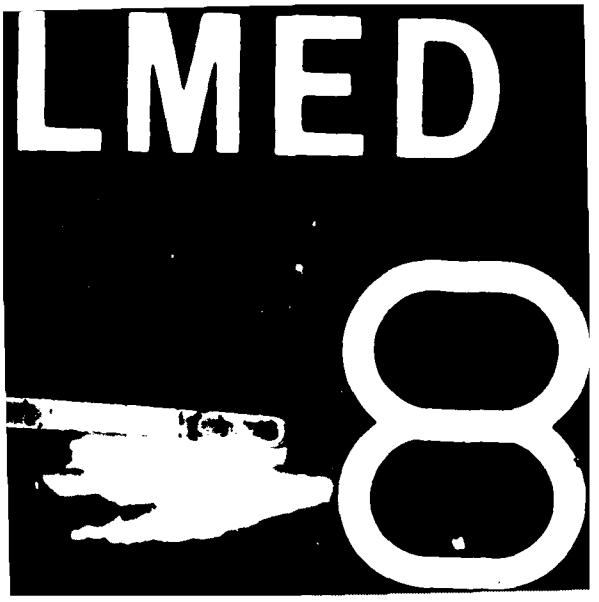


FIGURE H-17 OIL & GREASE (SEDIMENT)




LMED
8